55-1520-240-10/989

TM 55-1520-240-10

TECHNICAL MANUAL

OPERATOR'S MANUAL ARMY CH-47D HELICOPTER

This copy is a reprint which includes current pages from Changes 1-22.

HEADQUARTERS DEPARTMENT OF THE ARMY

10 NOVEMBER 1982

WARNING DATA

TABLE OF CONTENTS

INTRODUCTION

DESCRIPTION AND OPERATION

AVIONICS

MISSION EQUIPMENT

OPERATING LIMITS AND RESTRICTIONS

WEIGHT/BALANCE AND LOADING

PERFORMANCE DATA

NORMAL PROCEDURES

EMERGENCY PROCEDURES

REFERENCES

ABBREVIATIONS AND TERMS

ALPHABETICAL INDEX

READEX FICHE best copy available

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C 22

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2-53 and 2-54	2-53 and 2-54
3-3 and 3-4	3-3 and 3-4
3-5 and 3-6	3-5 and 3-6
3-25 and 3-26	3-25 and 3-26
- - -	3-26.1 and 3-26.2
9-19 and 9-20	9-19 and 9-20

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9-13 and 9-14	9-13 and 9-14
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2-75 and 2-76	2-75 and 2-76
-----	2-76.1/2-76.2
4-33 and 4-34	4-33 through 4-38
5-11 and 5-12	5-11 and 5-12
6-1 through 6-6	6-1 and 6-2
-----	6-6
6-26.1/6-26.2	6-26.1 and 6-26.2
6-33 and 6-34	6-33 and 6-34
-----	6-42.1/6-42.2
6-43 and 6-44	6-43 and 6-44
-----	6-46.1 through 6-46.5/6-46.6
-----	8-4.1/8-4.2
8-5 and 8-6	8-5 and 8-6
8-13 and 8-14	8-13 and 8-14
9-1 and 9-2	9-1 and 9-2
9-14.1/9-14.2	9-14.1/9-14.2
A-1/A-2	A-1/A-2
B-1 and B-2	B-1 and B-2
Index-1 and Index-2	Index-1 and Index-2
Index-5 and Index-6	Index-5 and Index-6
-----	Index-6.1/Index-6.2
Index-9 and Index-10	Index-9 and Index-10
Index-11/Index-12	Index-11/Index-12

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5-9 and 5-10	5-9 and 5-10
7-91 through 7-94	7-91

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2-81 and 2-82	2-81 and 2-82
5-3 and 5-4	5-3 and 5-4
7-93 and 7-94	7-93 and 7-94

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2-6.1/2-6.2	2-6.1/2-6.2
2-7 and 2-8	2-7 and 2-8
2-43 and 2-44	2-43 and 2-44
2-69 and 2-70	2-69 and 2-70
---	2-74.1/2-74.2
2-75 and 2-76	2-75 and 2-76
2-77 and 2-78	2-77 and 2-78
2-79 and 2-80	2-79 and 2-80
3-7 and 3-8	3-7 and 3-8
3-9 and 3-10	3-9 and 3-10
3-25 and 3-26	3-25 and 3-26
4-11 and 4-12	4-11 and 4-12
4-17 and 4-18	4-17 and 4-18
4-25 and 4-26	4-25 and 4-26
5-11 and 5-12	5-11 and 5-12
6-29 and 6-30	6-29 and 6-30
6-39 and 6-40	6-39 and 6-40
6-41 and 6-42	6-41 and 6-42
7-1 and 7-2	7-1 and 7-2
7-2.1/7-2.2	7-2.1/7-2.2
7-3 and 7-4	7-3 and 7-4
7-5 and 7-6	7-5 and 7-6
7-7 and 7-8	7-7 and 7-8
7-11/7-12	7-11/7-12
8-1 and 8-2	8-1 and 8-2
8-3/8-4	8-3 and 8-4
8-5 through 8-10	8-5 through 8-10
8-10.1/8-10.2	---
8-11 through 8-18	8-11 through 8-18
8-19 and 8-20	8-19/8-20
8-21 and 8-22	---
9i and 9ii	---
9-3 and 9-4	9-3 and 9-4
9-9 through 9-14	9-9 through 9-14
---	9-14.1/9-14.2
9-15 through 9-18	9-15 through 9-18

Remove pages	Insert pages
9-21 and 9-22	9-21 and 9-22
A-1/A-2	A-1/A-2
Index 1 through Index 10	Index 1 through Index 10
Index 11/Index 12	Index 11/Index 12

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2-39 and 2-40	2-39 and 2-40
8-5 and 8-6	8-5 and 8-6
8-11 and 8-12	8-11 and 8-12
8-15 and 8-16	8-15 and 8-16

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----	8-7/8-8
8-9 and 8-10	8-9 and 8-10

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2-9 through 2-12	2-9 through 2-12
---	2-12.1/2-12.2
2-13 and 2-14	2-13 and 2-14
---	2-14.1/2-14.2
2-15 and 2-16	2-15 and 2-16
2-19 and 2-20	2-19 and 2-20
2-31 and 2-32	2-31 and 2-32
2-37 through 2-56	2-37 through 2-56
2-61 and 2-62	2-61 and 2-62
---	2-62.1 through 2-62.7/2-62.8
2-65 and 2-66	2-65 and 2-66
---	2-66.1/2-66.2
2-69 and 2-70	2-69 and 2-70
2-75 and 2-76	2-75 and 2-76
3-3 and 3-4	3-3 and 3-4
3-4.1/3-4.2	3-4.1/3-4.2
3-5 and 3-6	3-5 and 3-6
3-6.1/3-6.2	3-6.1/3-6.2
3-7 through 3-10	3-7 through 3-10
3-10.1/3-10.2	3-10.1/3-10.2
3-11 through 3-14	3-11 through 3-14
---	3-14.1/3-14.2
3-15 through 3-27/3-28	3-15 through 3-27/3-28
4-3 and 4-4	4-3 and 4-4
---	4-28.1/4-28.2
4-29 and 4-30	4-29 and 4-30
5-3 through 5-6	5-3 through 5-6
5-11 and 5-12	5-11 and 5-12
7-1 and 7-2	7-1 and 7-2
---	7-2.1/7-2.2
7-7 through 7-10	7-7 through 7-10
7-12 through 7-16	7-12 through 7-16
7-17 and 7-18	7-18
7-21 through 7-24	7-21 through 7-24
---	7-24.1 and 7-24.2
---	7-28.1 through 7-28.3/7-28.4

Remove pages	Insert pages
7-29 and 7-30	7-29 and 7-30
---	7-32.1/7-32.2
7-33 and 7-34	7-33 and 7-34
---	7-34.1 and 7-34.2
---	7-38.1 through 7-38.3/7-38.4
7-39 through 7-44	7-39 through 7-44
---	7-44.1 through 7-44.3/7-44.4
---	7-48.1 through 7-48.3/7-48.4
7-49 and 7-50	7-49 and 7-50
7-53 and 7-54	7-53 and 7-54
---	7-54.1 through 7-54.3/7-54.4
---	7-58.1 through 7-58.3/7-58.4
7-59 and 7-60	7-59 and 7-60
7-63 and 7-64	7-63 and 7-64
---	7-64.1 through 7-64.3/7-64.4
---	7-68.1/7-68.2
---	7-68.3/7-68.4
7-69 and 7-70	7-69 and 7-70
---	7-72.1 and 7-72.2
7-73 and 7-74	7-73 and 7-74
7-77 through 7-82	7-77 through 7-82
7-93 and 7-94	7-93 and 7-94
8-3/8-4	8-3/8-4
8-5 and 8-6	8-5 and 8-6
9-5 through 9-10	9-5 through 9-10
9-15 through 9-18	9-15 through 9-18
9-21 and 9-22	9-21 and 9-22
A-1/A-2	A-1/A-2
Index 7 and Index 8	Index 7 and Index 8

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8-5 and 8-6	8-5 and 8-6
8-6.1/8-6.2	8-6.1/8-6.2
8-9 and 8-10	8-9 and 8-10
---	8-10.1/8-10.2
8-15 and 8-16	8-15 and 8-16

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The Adjutant General

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To be distributed in accordance with DA Form 12-31, AVUM and AVIM Maintenance requirements for CH-47D Helicopter, Cargo Transport.

URGENT

WARNING

Personnel performing operations, procedures, and practices which are included or implied in this technical manual shall observe the following warnings. Disregard of these warnings and precautionary information can cause serious injury or death.

WARNINGS, CAUTIONS, NOTES

Warnings, cautions, and notes are used in this manual to emphasize important and critical instructions and are used for the following conditions:

WARNING

An operating procedure, practice, etc., which, if not correctly followed, could result in personnel injury or loss of life.

CAUTION

An operating procedure, practice, etc., which, if not strictly observed, could result in damage to or destruction of equipment.

NOTE

An operating procedure, condition, etc., which is essential to highlight.

STARTING ENGINES

Coordinate all cockpit actions with ground observer. Insure that wheels are chocked (if applicable), rotor and blast areas are clear, and fire guard is posted.

GROUND OPERATION

Engines will be started and operated only by authorized personnel.

ROTOR BLADES

Beware of moving rotor blades, particularly the blades of the forward rotor system.

HIGH VOLTAGE

All ground handling personnel must be informed of high voltage hazards when making external cargo hookups.

FIRE EXTINGUISHER

Exposure to high concentrations of fire extinguishing agent or decomposition products should be avoided. The liquid should not be allowed to come into contact with the skin, as it may cause frostbite or low temperature burns.

ARMAMENT

Loaded weapons or weapons being loaded or unloaded, shall be pointed in a direction which offers the least exposure to personnel or property in the event of accidental firing. Personnel should remain clear of the hazardous area of all loaded weapons.

VERTIGO

Turn the anti-collision lights off during flight through clouds. This will eliminate light reflections from the clouds, which could cause vertigo.

CARBON MONOXIDE

When smoke, suspected carbon monoxide fumes, or symptoms of anoxia exist, the crew should immediately ventilate the aircraft.

HANDLING FUEL AND OIL

Turbine fuels and lubricating oils contain additives which are poisonous and readily absorbed through the skin. Do not allow them to remain on skin longer than necessary.

RADIOACTIVE MATERIALS

Instrument dials on CH-47 series aircraft contain radioactive materials. If an instrument is broken or becomes unsealed, avoid personal contact with the item. Use forceps or gloves made of rubber or polyethylene to pick up contaminated material. Place the material and the gloves in a plastic bag, seal the bag, and dispose of it as radioactive waste in accordance with AR 755-15 and TM 3-261. (Refer to TB 55-1500-314-25.)

NOISE LEVELS

Sound pressure levels in this aircraft during some operating conditions exceed the Surgeon General's hearing conservation criteria, as defined in TB MED 251. Hearing protection devices, such as the aviator helmet or ear plugs are required to be worn by all personnel in and around the aircraft during its operation.

HAZARDOUS CARGO

Items of cargo possessing dangerous physical properties, such as explosives, acids, flammables, etc., must be handled with extreme caution and in accordance with established regulations. Ref: TM 38-250.

TECHNICAL MANUAL

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 10 November 1982

Operator's Manual

ARMY MODEL
CH-47D HELICOPTER

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to Commander, US Army Troop Support and Aviation Materiel Readiness Command, ATTN: DRSTS-MPSD, 4300 Goodfellow Boulevard, St. Louis, Missouri 63120. A reply will be furnished to you.

		Page
	WARNING PAGE	
CHAPTER 1	*INTRODUCTION*	1-1
CHAPTER 2	*AIRCRAFT AND SYSTEMS DESCRIPTION AND OPERATION*	2-1
SECTION I	HELICOPTER	2-1
SECTION II	EMERGENCY EQUIPMENT	2-14
SECTION III	ENGINES AND RELATED SYSTEMS	2-17
SECTION IV	FUEL SYSTEM	2-22
SECTION V	FLIGHT CONTROLS	2-29
SECTION VI	HYDRAULIC SYSTEMS	2-34
SECTION VII	POWER TRAIN SYSTEM	2-36
SECTION VIII	ROTOR SYSTEM	2-38
SECTION IX	UTILITY SYSTEMS	2-39
SECTION X	HEATING, VENTILATING, COOLING, AND ENVIRONMENTAL SYSTEMS	2-43
SECTION XI	ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEMS	2-46
SECTION XII	AUXILIARY POWER UNIT	2-54
SECTION XIII	LIGHTING	2-56
SECTION XIV	FLIGHT INSTRUMENTS	2-62
SECTION XV	SERVICING, PARKING, AND MOORING	2-69
CHAPTER 3	*AVIONICS*	3-1
SECTION I	GENERAL	3-1
SECTION II	COMMUNICATIONS	3-4
SECTION III	NAVIGATION EQUIPMENT	3-12
SECTION IV	TRANSPONDERS AND RADAR	3-25
CHAPTER 4	*MISSION EQUIPMENT*	4-1
SECTION I	MISSION AVIONICS	4-1
SECTION II	ARMAMENT	4-7
SECTION III	CARGO HANDLING SYSTEMS	4-18
CHAPTER 5	*OPERATING LIMITS AND RESTRICTIONS*	5-1
SECTION I	GENERAL	5-1
SECTION II	SYSTEM LIMITS	5-1
SECTION III	POWER LIMITS	5-5
SECTION IV	LOADING LIMITS	5-6
SECTION V	AIRSPEED LIMITS	5-14
SECTION VI	MANEUVERING LIMITS	5-10
SECTION VII	ENVIRONMENTAL RESTRICTIONS	5-10
SECTION VIII	WATER OPERATIONS LIMITATIONS	5-12
SECTION IX	ADDITIONAL LIMITATIONS	5-13

		Page
CHAPTER 6	*WEIGHT/BALANCE AND LOADING*	6-1
SECTION I	GENERAL	6-1
SECTION II	WEIGHT AND BALANCE	6-1
SECTION III	FUEL/OIL	6-6
SECTION IV	PERSONNEL	6-8
SECTION V	MISSION EQUIPMENT	6-18
SECTION VI	CARGO LOADING	6-19
SECTION VII	LOADING LIMITS	6-47
CHAPTER 7	*PERFORMANCE DATA*	7-1
SECTION I	INTRODUCTION	7-1
SECTION II	PERFORMANCE PLANNING	7-4
SECTION III	EMERGENCY TORQUE AVAILABLE	7-6
SECTION IV	MAXIMUM TORQUE AVAILABLE	7-8
SECTION V	CONTINUOUS TORQUE AVAILABLE	7-12
SECTION VI	HOVER	7-14
SECTION VII	TAKEOFF	7-18
SECTION VIII	CRUISE	7-21
SECTION IX	DRAG	7-78
SECTION X	CLIMB/DESCENT	7-80
SECTION XI	FUEL FLOW	7-83
SECTION XII	AIRSPEED CALIBRATION	7-86
CHAPTER 8	*NORMAL PROCEDURES*	8-1
SECTION I	MISSION PLANNING	8-1
SECTION II	OPERATING PROCEDURES AND MANEUVERS	8-1
SECTION III	FLIGHT CHARACTERISTICS	8-17
SECTION IV	ADVERSE ENVIRONMENTAL CONDITIONS	8-19
SECTION V	CREW DUTIES	8-22
CHAPTER 9	*EMERGENCY PROCEDURES*	9-1
SECTION I	HELICOPTER SYSTEMS	9-1
SECTION II	MISSION EQUIPMENT	9-23
APPENDIX A	*REFERENCES*	A-1
APPENDIX B	*GLOSSARY*	B-1
INDEX	*INDEX*	Index-1

CHAPTER 1

INTRODUCTION

1-1. General.

These instructions are for use by the operator. They apply to CH-47D helicopters.

1-2. Helicopter Description.

This manual contains the complete operating instructions and procedures for the CH-47D helicopter. It is powered by two T55-L-712 engines. The primary mission of the helicopter is troop and cargo transport. The observance of limitations, performance, and weight and balance data provided is mandatory. Your flying experience is recognized, therefore, basic flight principles are not included. It is required that THIS MANUAL BE CARRIED IN THE HELICOPTER AT ALL TIMES.

1-3. Introductory Material.

The following paragraphs describe certain sections of this manual, referenced forms, manuals, and Army Regulations. Also included is the procedure to follow to report errors or to recommend changes.

1-4. Appendix A, References.

Appendix A is a listing of official publications cited within the manual applicable to and available to flight crews.

1-5. Appendix B, Abbreviations.

Appendix B is a list of the abbreviations used in this manual.

1-6. Index.

The index lists in alphabetical order, every titled paragraph, figure, and table contained in this manual. Chapter 7, Performance Data and Chapter 9, Emergency Procedures have their own index within the chapter.

1-7. Army Aviation Safety Program.

Reports necessary to comply with the Army Aviation Safety Program are prescribed in AR385-40.

1-8. Destruction of Army Material to Prevent Enemy Use.

For information concerning destruction of Army material to prevent enemy use, refer to TM 750-244-1-5.

1-9. Forms and Records.

Army aviators flight record and aircraft maintenance records which are to be used by crewmembers are prescribed in TM 38-750 and TM 55-405-9.

1-10. Change Symbol Explanation.

Changes, except as noted below, to the text and tables, including new material on added pages, are indicated by a vertical line. The vertical line is in the outer margin and extends close to the entire area of the material affected with the following exception: pages with emergency markings, which consist of black diagonal lines around three edges, may have the vertical line or change symbol placed along the inner margins. Symbols show current changes only. A miniature pointing hand symbol is used to denote a change to an illustration. However, a vertical line in the outer margin, rather than miniature pointing hands, is used when there have been extensive changes made to an illustration. Change symbols are not used to indicate changes in the following:

a. Introductory material.

b. Indexes and tabular data where the change cannot be identified.

c. Blank space resulting from the deletion of text, an illustration, or a table.

d. Correction of minor inaccuracies, such as spelling, punctuation, relocation of material, etc., unless such correction changes the meaning of instructive information and procedures.

1-11. Aircraft Designation System.

The designation system prescribed by AR70-50 is used in aircraft designations as follows:

Example CH-47D
C - Mission symbol (cargo)
H - Basic mission and type symbol (Helicopter)
47 - Design number
D - Series symbol

1-12. Use of "Shall, Should, and May".

Within this technical manual, the word "shall" is used to indicate a mandatory requirement. The word "should" is used to indicate a nonmandatory but preferred method of accomplishment. The word "may" is used to indicate an acceptable method of accomplishment.

CHAPTER 2

AIRCRAFT AND SYSTEMS DESCRIPTION AND OPERATION

SECTION I HELICOPTER

2-1. General.

The CH-47D (figure 2-1 thru 2-3) is a twin-turbine-engine, tandem rotor helicopter designed for transportation of cargo, troops, and weapons during day, night, visual, and instrument conditions. (Unless otherwise noted, numbers refer to figure 2-1.) The helicopter is powered by two T55-L-712 shaft-turbine engines (24) on the aft fuselage. The engines simultaneously drive two tandem three-bladed counterrotating rotors (13 and 18) thru engine transmissions (27), a combining transmission (16), drive shafting (14), and reduction transmissions (12 and 22). The forward transmission is on the forward pylon above the cockpit (1). The aft transmission, the combining transmission, and drive shafting are in the aft cabin section and aft pylon section (3 and 4). Drive shafting from the combining transmission to the forward transmission is housed in a tunnel along the top of the fuselage. When the rotors are stationary, a gas-turbine auxiliary power unit (21) drives a generator and hydraulic pump to furnish hydraulic and electrical power for ground operations. Fuel is carried in pods on each side of the fuselage. The helicopter is equipped with four non-retractable landing gear. An entrance door (15) is at the forward right side of the cargo compartment (2). At the rear of the cargo compartment is a hydraulically powered loading ramp (25). The pilot's seat (9) and controls are at the right side of the cockpit; the copilot's seat (39) and controls are on the left side. See figure 2-5 for typical cockpit and controls.

2-2. Gross Weight.

The maximum gross weight of the CH-47D is 50,000 pounds. Refer to Chapters 5 and 6 for additional weight information.

2-3. Landing Gear System.

The landing gear system consists of four non-retractable landing gear mounted on the fuselage pods. The forward landing gear are a fixed-cantilever type and have twin wheels. The aft landing gear are of the single-wheel, full-swivel (360°) type which can be power centered and locked in trailed position. In addition, the aft right landing gear can be steered from the cockpit by a control knob on the console. Each landing gear has an individual air-oil shock strut and is equipped with the tube-type tires.

2-4. Landing Gear Proximity Switches.

a. Two proximity switches are installed, one on each aft landing gear. Each switch is activated when its associated shock strut is compressed during touchdown. The switches improve ground handling by reducing pitch axis gain of the AFCS, by cancelling stick input to the dash actuators, and by driving both LCT actuators to the ground position. In addition to the above functions, the switch on the right aft landing gear, when activated, disables the flare dispenser to prevent accidental flare release and prevents cancelling of mode 4 transponder codes.

b. On aircraft equipped with ground contact annunciator lights, activation of the proximity switches when the associated shock strut is depressed will cause the associated ground contact annunciator light on the maintenance panel to come on.

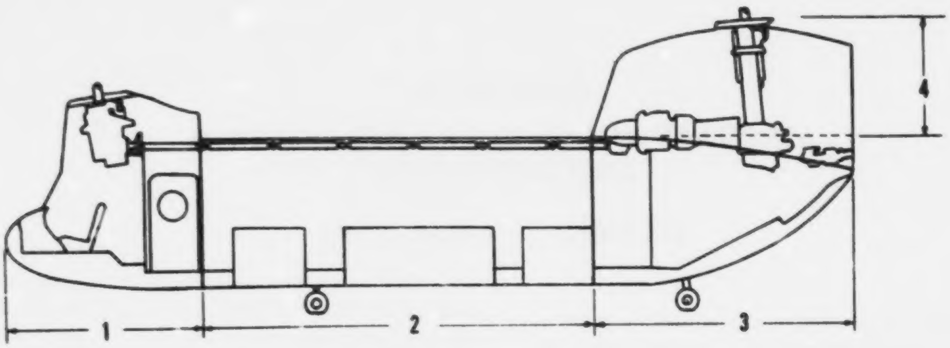
CAUTION

Should either or both ground contact annunciator lights remain on after lift-off to hover, the indicated system's DASH will not function properly in forward flight. If both ground contact annunciator lights remain on after lift-off, the auto function of both cyclic trims system will be inoperative.

c. Aft landing gear proximity switches are not activated in a water landing. As a result, dash actuators will respond to longitudinal stick motion, producing an apparent increase in control sensitivity. Cyclic motion of ±¾ inch from neutral, if held, will drive the dash actuators hardover. If longitudinal cyclic movement is required for taxiing, set the AFCS SYSTEM SEL switch to OFF.

2-5. Steering and Swivel Lock System. The aft right landing gear is hydraulically steerable and electrically controlled by a control knob on the steering control box on the console. The three position SWIVEL switch, also on the STEERING CONTROL panel, controls operation of power steering and swivel locks. The switch positions are arranged so the power steering system cannot be energized and used with swivel locks engaged. Hydraulic power to operate the power steering actuator and the swivel locks is supplied by the utility hydraulic system thru the utility system pressure control module and a separate power steering and swivel lock module. Electrical power to control the steering and swivel locks system is supplied by the 28-volt No. 1 dc bus thru the BRAKE STEER circuit breaker on the No. 1 power distribution panel.

2-6. Power Steering Control Box. The power steering control box (figure 2-4) is on the aft end of the console. The box is marked STEERING CONTROL. It contains the SWIVEL switch, the steering control knob, a fail-safe module and relay, and a servoamplifier. The fail-safe module monitors the steering electrical circuits. A



1. FORWARD CABIN SECTION (COCKPIT)
2. CABIN FUSELAGE SECTION
3. AFT CABIN SECTION
4. PYLON SECTION
5. PITOT TUBES
6. RADAR WARNING ANTENNA
7. TRANSPONDER ANTENNA
8. CONSOLE
9. PILOT'S SEAT
10. GLIDE SLOPE ANTENNA
11. SPOILERS
12. FORWARD TRANSMISSION
13. FORWARD ROTOR
14. DRIVE SHAFT
15. CABIN DOOR
16. COMBINING TRANSMISSION
17. ENGINE AND COMBINING TRANSMISSION OIL COOLER AND DUCT
18. AFT ROTOR
19. AFT ROTOR DRIVE SHAFT
20. RADAR WARNING ANTENNA
21. AUXILIARY POWER UNIT

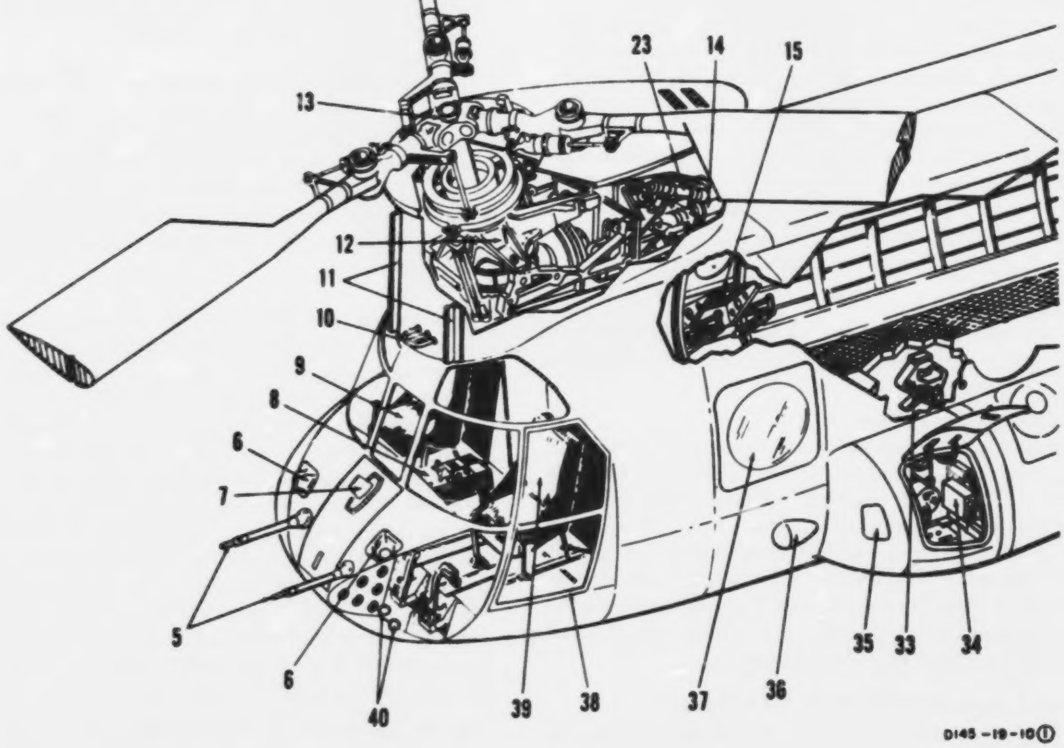

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Figure 2-1. General Arrangement (Sheet 1 of 2)

22 AFT TRANSMISSION
23 HYDRAULIC POWER UNITS AND TANKS
24 ENGINE AND SCREEN
25 RAMP
26 STRAKES
27 ENGINE TRANSMISSION
28 JETTISONABLE CABIN WINDOW (TYPICAL 6 PLACES)
28.1 JETTISONABLE CABIN BUBBLE WINDOW (TYPICAL 2 PLACES)
29 AFT CARGO HOOK
30 LEFT AFT AUXILIARY FUEL TANK
31 UTILITY HATCH, CENTER CARGO HOOK
32 LEFT MAIN FUEL TANK
33 FORWARD CARGO HOOK
34 LEFT ELECTRICAL COMPARTMENT
35 EXTERNAL POWER RECEPTACLE
36 NO. 1 FLIGHT CONTROL HYDRAULIC SYSTEM GROUND TEST CONNECTIONS
37 CABIN ESCAPE HATCH
38 JETTISONABLE DOOR
39 COPILOT'S SEAT
40 AFCS PORTS

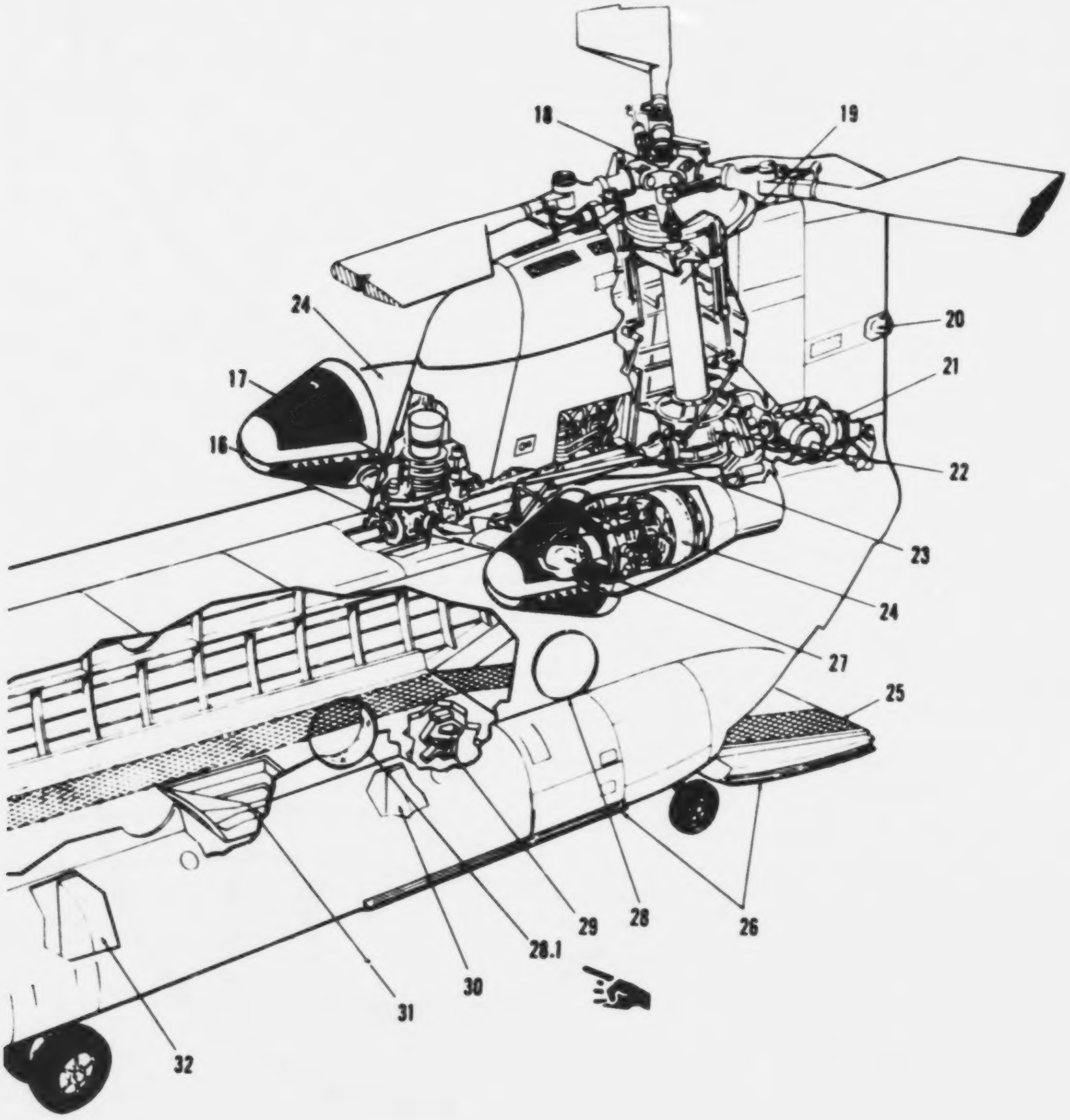

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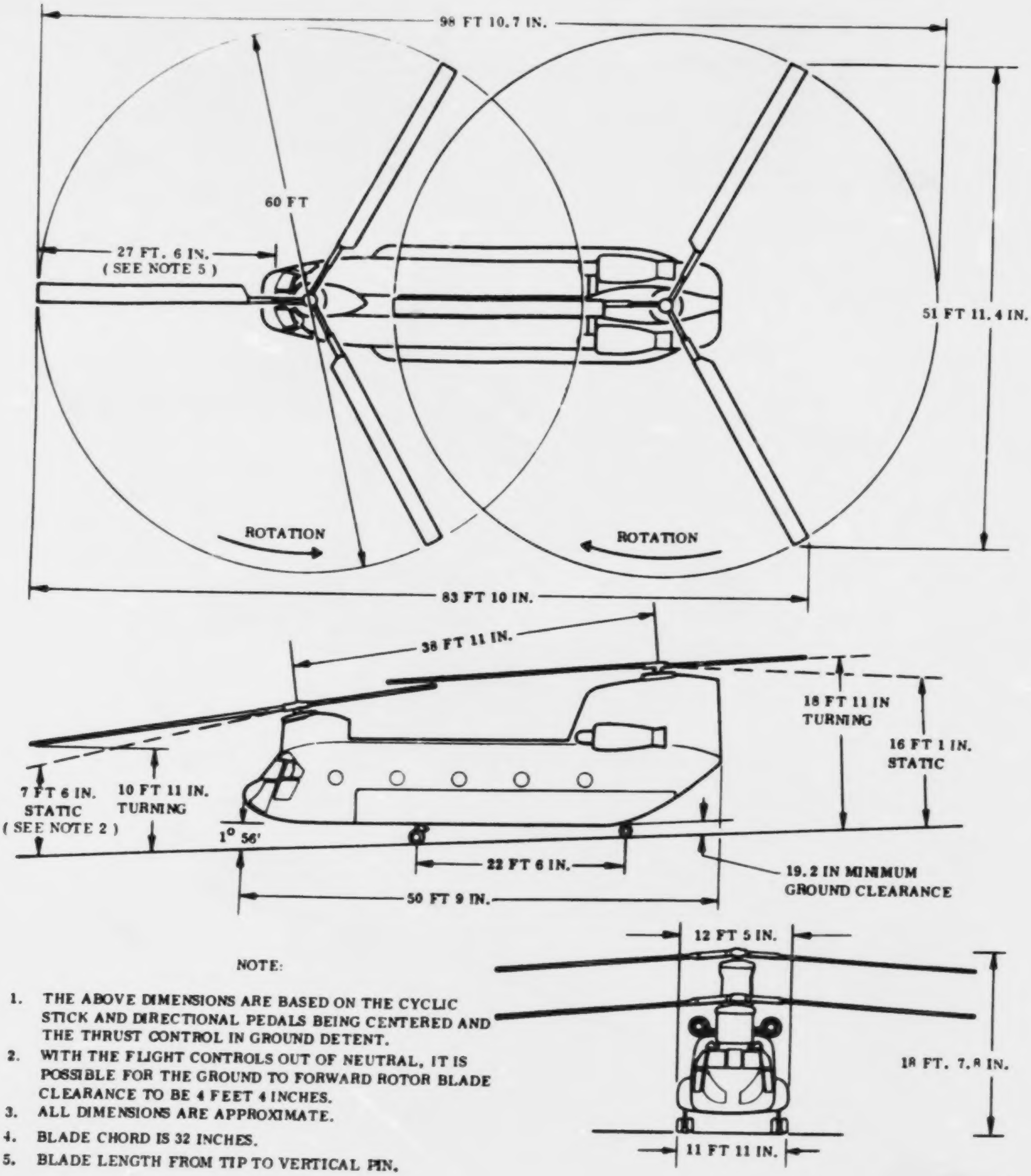
Figure 2-1. General Arrangement (Sheet 2 of 2)


98 FT 10.7 IN.
60 FT
27 FT. 6 IN.
(SEE NOTE 5)
51 FT 11.4 IN.
ROTATION
ROTATION
83 FT 10 IN.
38 FT 11 IN.
18 FT 11 IN
TURNING
16 FT 1 IN.
STATIC
7 FT 6 IN.
STATIC
(SEE NOTE 2)
10 FT 11 IN.
TURNING
1° 56'
22 FT 6 IN.
19.2 IN MINIMUM
GROUND CLEARANCE
50 FT 9 IN.
12 FT 5 IN.
18 FT. 7.8 IN.
11 FT 11 IN.
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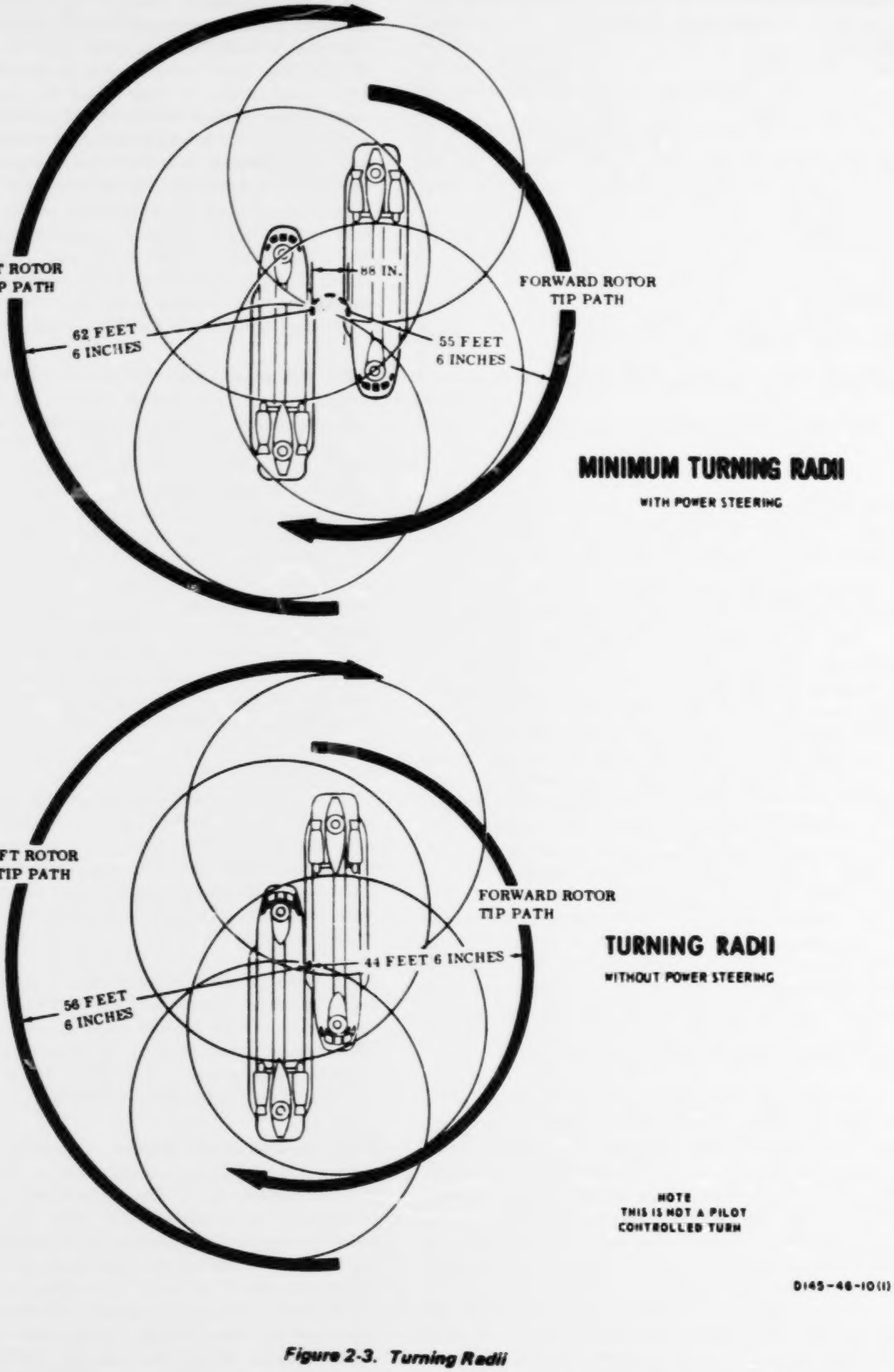
NOTE:

1. THE ABOVE DIMENSIONS ARE BASED ON THE CYCLIC STICK AND DIRECTIONAL PEDALS BEING CENTERED AND THE THRUST CONTROL IN GROUND DETENT.
2. WITH THE FLIGHT CONTROLS OUT OF NEUTRAL, IT IS POSSIBLE FOR THE GROUND TO FORWARD ROTOR BLADE CLEARANCE TO BE 4 FEET 4 INCHES.
3. ALL DIMENSIONS ARE APPROXIMATE.
4. BLADE CHORD IS 32 INCHES.
5. BLADE LENGTH FROM TIP TO VERTICAL PIN.

Figure 2-2. Principal Dimensions Diagram



MINIMUM TURNING RADII

WITH POWER STEERING

TURNING RADII

WITHOUT POWER STEERING

NOTE
THIS IS NOT A PILOT
CONTROLLED TURN

AFT ROTOR TIP PATH
88 IN.
FORWARD ROTOR TIP PATH
62 FEET 6 INCHES
55 FEET 6 INCHES
AFT ROTOR TIP PATH
FORWARD ROTOR TIP PATH
44 FEET 6 INCHES
56 FEET 6 INCHES
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Figure 2-3. Turning Radii

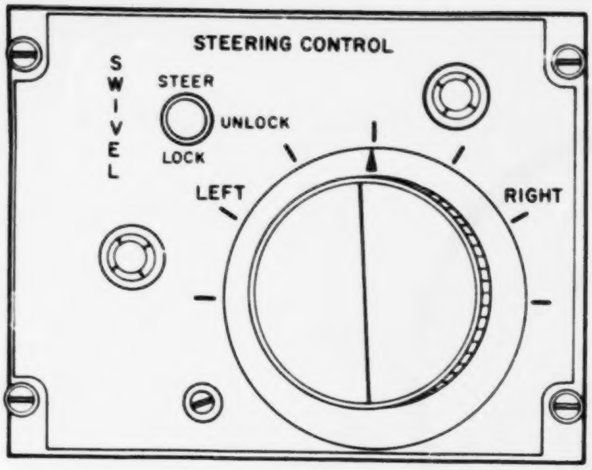


Figure 2-4. Power Steering Control Panel

malfunction which could cause a steering hardover will be detected by the fail-safe module and relay which disables the system and turns on the PWR STEER caution light.

2-7. Swivel and Steering Control. The three-position SWIVEL switch is on the STEERING CONTROL box in the console. The switch is labeled SWIVEL. The switch positions are labeled STEER, UNLOCK, and LOCK. Setting the switch to STEER applies 28-volt dc to the circuits in the power steering control box and arms the power steering actuator. Rotating the steering control knob with the SWIVEL switch at STEER will activate the power steering actuator and the aft right wheel will swivel when the power steering knob is rotated. Setting the SWIVEL switch to UNLOCK deenergizes the power steering circuits in the control box and the power steering actuator, while maintaining the swivel locks in the disengaged position. At UNLOCK, both aft wheels are free to swivel. Setting the SWIVEL switch to LOCK energizes the swivel lock and centering cam control valve. Utility system pressure is directed to the lock port of the swivel lock cylinder and centering cam. The aft wheels will rotate to neutral trail position and the swivel lock will engage when helicopter weight is lifted from the rear wheels. AFCS heading hold is disabled at STEER and UNLOCK.

2-8. Control Knob. The power steering knob is on the right side of the power STEERING CONTROL panel (figure 2-4). Index marks around the knob indicate degrees of knob rotation to LEFT and RIGHT in increments of 30°. These index marks do not represent wheel turn angle: they are reference marks only. The control knob is spring-loaded to zero turn angle. Power steering is accomplished by rotating the control knob a given amount in the desired direction. When the control knob is rotated, a servo valve on the power steering actuator regulates hydraulic pressure to extend or retract the actuator. A feedback variable resistor, also on the power steering actuator, stops actuator travel when the selected turn radius is reached.

2-9. Power Steering Caution Light. A power steering caution light is on the master caution panel on the console. (See figure 2-46.) The caution light is marked PWR STEER. The light indicates that power steering circuits have failed or the aft right wheel has exceeded turning limits. These limits are set at 58° for a left turn and 82° for a right turn. The aft right wheel is deflected an unequal number of degrees in one direction to produce an equal turn radius because of landing gear geometry. If turning limits are exceeded, an out-of-phase switch on the landing gear automatically closes the power steering solenoid valve, lights the caution light, and removes electrical power from the control box. To reenergize the power steering system, the landing gear must be returned within operating limits and the SWIVEL switch must be recycled.

2-10. Brakes and Steering Isolation Switch. The brakes and steering isolation switch is on the HYDRAULIC control panel on the overhead switch panel. (See figure 2-8.) It is labeled BRAKE STEER, ON and OFF. The switch isolates the brakes and steering hydraulic subsystem from the rest of the utility hydraulic system in the event of a leak in the subsystem. The normal position of the switch is ON. The switch is guarded to ON. Setting the switch to OFF, closes the power steering and brakes valve on the utility system pressure control module, isolating the brakes and steering the subsystem. With the switch at OFF, limited brake applications are available due to an emergency brake accumulator in the brake subsystem. Power to operate the isolation valve is from the 28-volt No. 1 dc bus thru the BRAKE STEER circuit breaker on the No. 1 power distribution panel.

2-11. Brake System.

The four wheels of the forward landing gear, and the two wheels of the aft landing gear, are equipped with self-adjusting disk brakes. Braking is accomplished on all wheels at all times. Both forward and aft brakes can be applied and brake pressure maintained by depressing the pedals. Hydraulic pressure is supplied by the utility hydraulic system.

2-12. Brake Pedals. When either the pilot's or copilot's brake pedals are depressed, pressure from the master brake cylinders goes to a transfer valve in the brake lines. This allows independent braking by either pilot. From these transfer valves, pressure is directed thru a parking brake valve to the forward and aft wheel brakes.

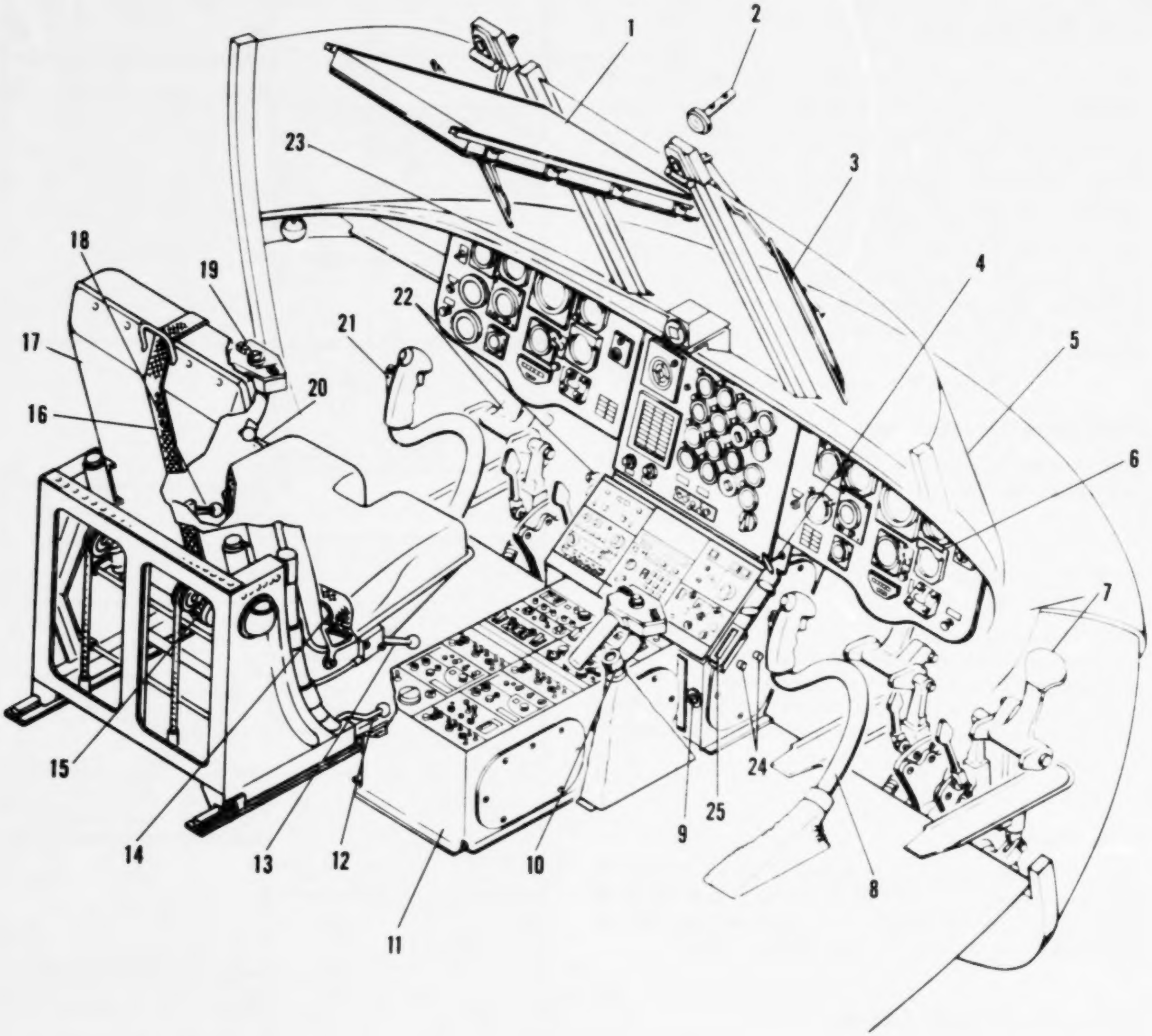
2-13. Parking Brake Handle. A parking brake handle (figure 2-5) is at the bottom left corner of the pilot's section of the instrument panel. The brake handle is mechanically connected to the parking brake valve. The parking brake handle is electrically connected to the PARK BRAKE ON caution light on the master caution panel. When the brake pedals are depressed and the parking brake handle is pulled OUT, pressure is trapped and maintained on forward and aft wheel brakes. At the same time, electrical power from the 28-volt No. 1 dc bus, thru the CAUTION PNL circuit breaker, lights the PARK BRAKE ON caution light.

The parking brakes must be released by applying pressure to the brake pedals. This action automatically opens the parking brake valve, retracts the parking brake handle, and puts out the caution light.

2-14. Parking Brake Caution Light. A parking brake caution light is on the master caution panel on the console. (See figure 2-46.) This light is electrically connected to the parking brake handle. When the handle is pulled OUT, the light marked PARK BRAKE ON comes on. When the brake pedals are depressed and the handle goes in, the light goes out. Power to operate this light is supplied by the 28-volt No. 1 dc bus thru the CAUTION PNL circuit breaker on the No. 1 power distribution panel.

2-15. Instrument and Control Panels.

Figures 2-6, 2-7, and 2-8 show the console, instrument panel, and the overhead switch panel.



1. Overhead switch panel
2. Free air temperature gage
3. Windshield wiper
4. Parking brake handle
5. Windshield
6. Instrument panel
7. Pilot's wheel brakes and directional pedals
8. Pilot's pitch-roll control (cyclic stick)
9. Ignition lock switch
10. Pilot's thrust control rod
11. Console
12. Horizontal seat adjustment lever
13. Vertical seat adjustment lever
14. Safety belt
15. Inertia reel
16. Shoulder harness
17. Seat
18. Rotational adjustment lever
19. Copilot's thrust control rod
20. Inertia reel lock
21. Copilot's pitch-roll control (cyclic stick)
22. Copilot's wheel brakes and directional pedals
23. Magnetic compass
24. Topping stop studs
25. Longitudinal stick position indicator

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Figure 2-5. Cockpit and Controls

2-16. Personnel/Cargo Doors.

Entry can be made thru either the main cabin door or the cargo door and ramp.

2-17. Main Cabin Door.

The main cabin entrance (15, figure 2-1) door is on the right side of the cargo compartment. The door is divided into two sections: the upper section containing a jettisonable panel and the lower section forming the entrance step. When opened, the upper section slides upward on overhead rails and the lower section swings downward. When closed, the two sections mate to form the complete door. Handles are provided on both the outside and inside of the door for accessibility. Refer to Chapter 5 for the allowable airspeed imposed on the helicopter while operating with the cabin entrance door sections in various positions.

2-18. Cargo Door and Ramp.

Refer to para 6-53 for detail description and operation of cargo door and ramp.

2-19. Pilot and Copilot Sliding Windows.

The upper section of each jettisonable door (38, figure 2-1) in the cockpit contains a sliding window. The window slides fore and aft and is locked and unlocked by a handle at the forward end of the jettisonable door. The handle is moved forward to lock the window and aft to unlock the window.

2-20. Seats.

The pilot's and copilot's seats (9 and 39, figure 2-1) are on tracks to permit forward-and-aft, vertical, and reclining position adjustments. Bungee cords in each seat exert an upward force on the seat when it is down or tilted.

2-21. Seat Fore-and-Aft Lever.

A fore-and-aft control lever (12, figure 2-5) for horizontal seat adjustment is on the right side of each seat support carriage. When the lever is pulled UP, the seat is unlocked and can be moved along the tracks on the cockpit floor. When the lever is released, the seat is locked in position horizontally. The total range of horizontal movement is 4 inches, in 1-inch increments.

2-22. Seat Vertical Lever.

Vertical seat adjustment (13, figure 2-5) is controlled by a lever on the right side of each seat. When this lever is pulled UP, the seat is unlocked and can be moved vertically along a track thru a range of 5 inches. The range is divided into ½-inch increments. When the lever is released, the seat is locked in position vertically.

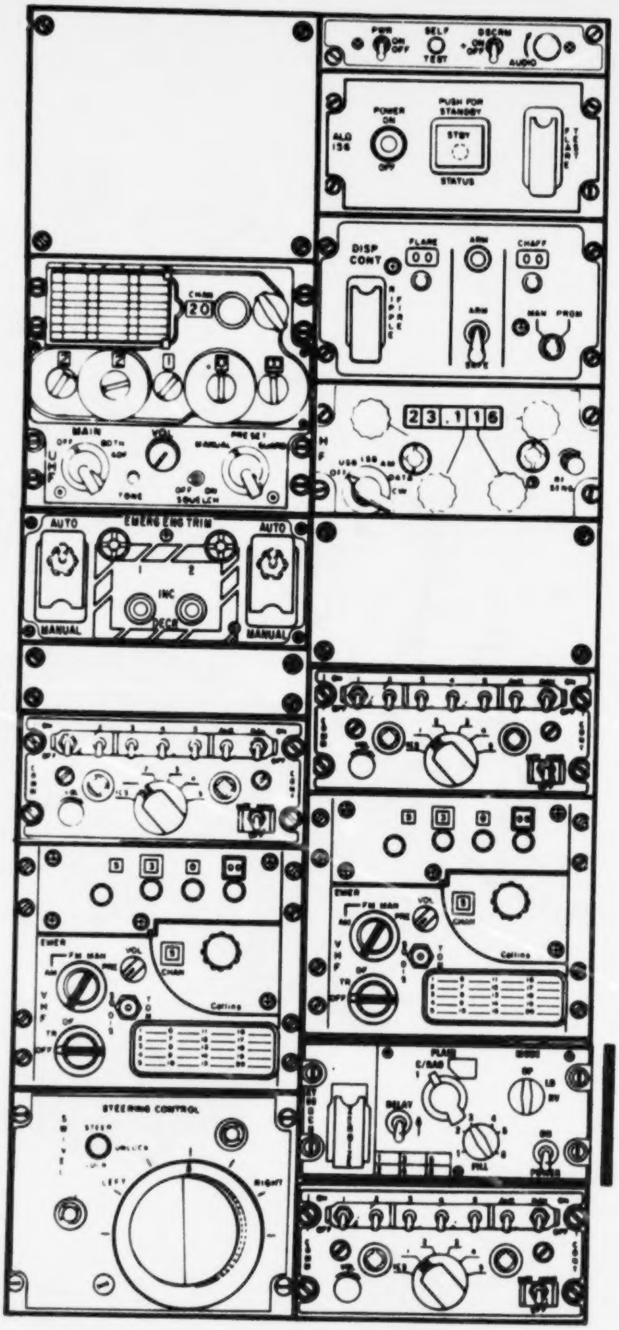


Figure 2-6. Console (Typical) (Sheet 1 of 2)

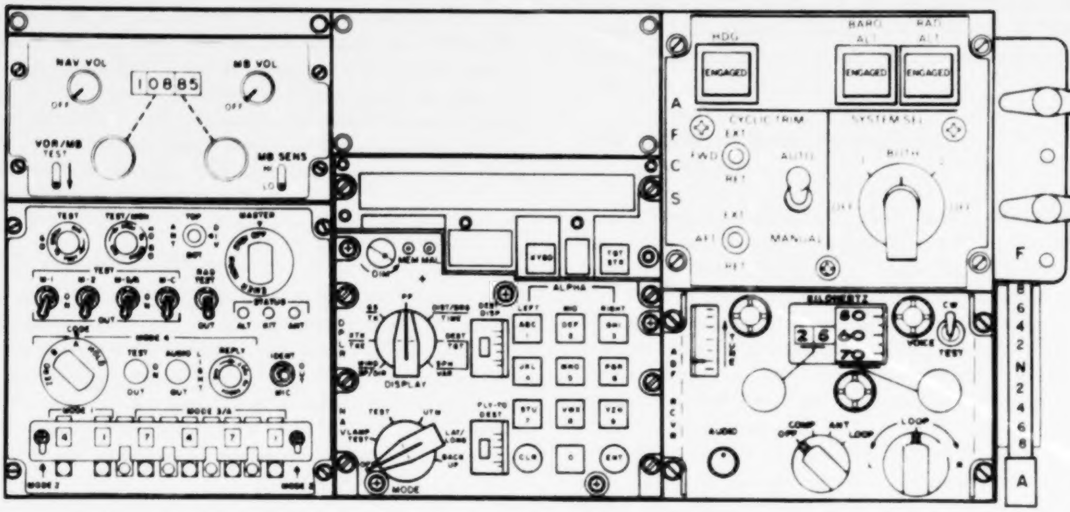

NAV VOL
OFF
1 0 8 8 5
MB VOL
OFF
VOR/MB
TEST
MB SENS
HI
LO
TEST
TEST/MON
TEST
M-1
M-2
M-3/A
M-C
RAD TEST
OUT
MASTER
STATUS
ALT
KIT
ANT
CODE
MODE 4
TEST
AUDIO
OUT
REPLY
IDENT
MIC
MODE 1
MODE 3/A
MODE 2
DIM
MEM MAL
KYBD
TGT STR
ALPHA
LEFT
MID
RIGHT
DIST/BRG TIME
DEST TGT
DEST DISP
ST/H TGT
DISPLAY
D P L R
ABC 1
DEF 2
GHI 3
JKL 4
MNO 5
PQR 6
STU 7
VWX 8
YZ* 9
CLR
0
ENT
FLY-TO DEST
TEST
UTM
LAT/LONG
VLAMP TEST
BACK UP
OFF
MODE
N A
A F C S
HDG
ENGAGED
BARO ALT
ENGAGED
RAD ALT
ENGAGED
CYCLIC TRIM
EXT
FWD
RET
AUTO
EXT
AFT
RET
MANUAL
SYSTEM SEL
BOTH
1
2
OFF
OFF
F
A
KILOHERTZ
2 6
60
70
VOICE
CW
TEST
ADF RCVR
AUDIO
COMP
OFF
ANT
LOOP
LOOP
8
6
4
2
N
2
4
6
8
9020

Figure 2-6. Console (Typical) (Sheet 2 of 2)

2-23. Seat Rotation Lever.

A control lever (18, figure 2-5) for adjusting the seat reclining position is on the left side of each seat. When this lever is pulled UP, the seat is unlocked and can be rotated thru a 15° tilt range divided into four equal increments. The seat, in effect, is pivoted up and down around a horizontal axis. When the lever is released, the seat is locked in the selected tilt position. This lever is not operational when armor plating is installed on the seat.

2-23.1. Armored Seats.

Both the pilot's and copilot's seats are equipped with a combination of fixed and adjustable ceramic armor panels (figure 2-6.1). Fixed panels are installed under the back and bottom seat cushions and on the outboard side of each seat. A shoulder panel is mounted on the outboard side of each seat. The shoulder panel is hinged from the seat back so it can be moved aside for ease of exit from the helicopter. The panel is secured in its normal position by a latch and an exerciser cord. Seat adjustments are the same as stated in paragraph 2-21 and 2-22. The seat rotation lever is not operational on the armored seat.

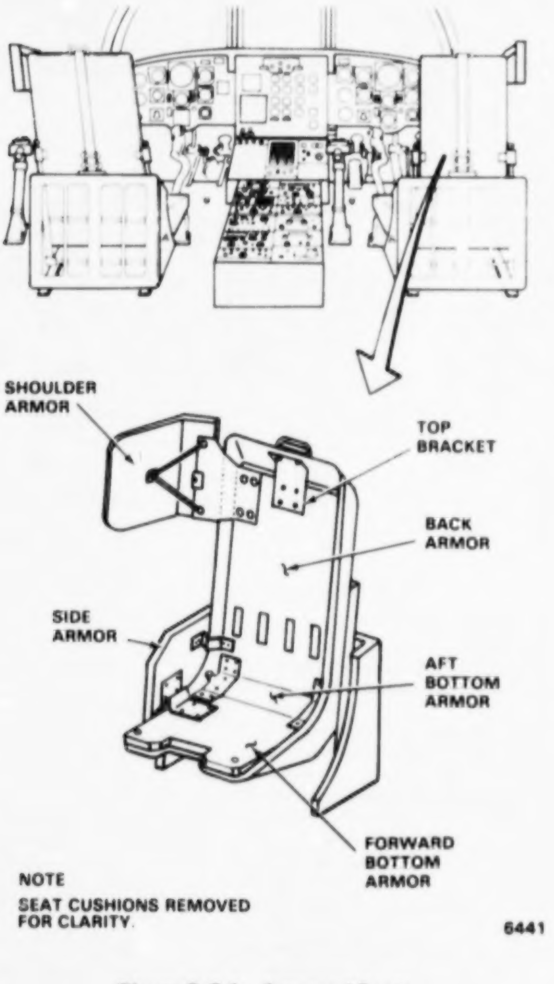


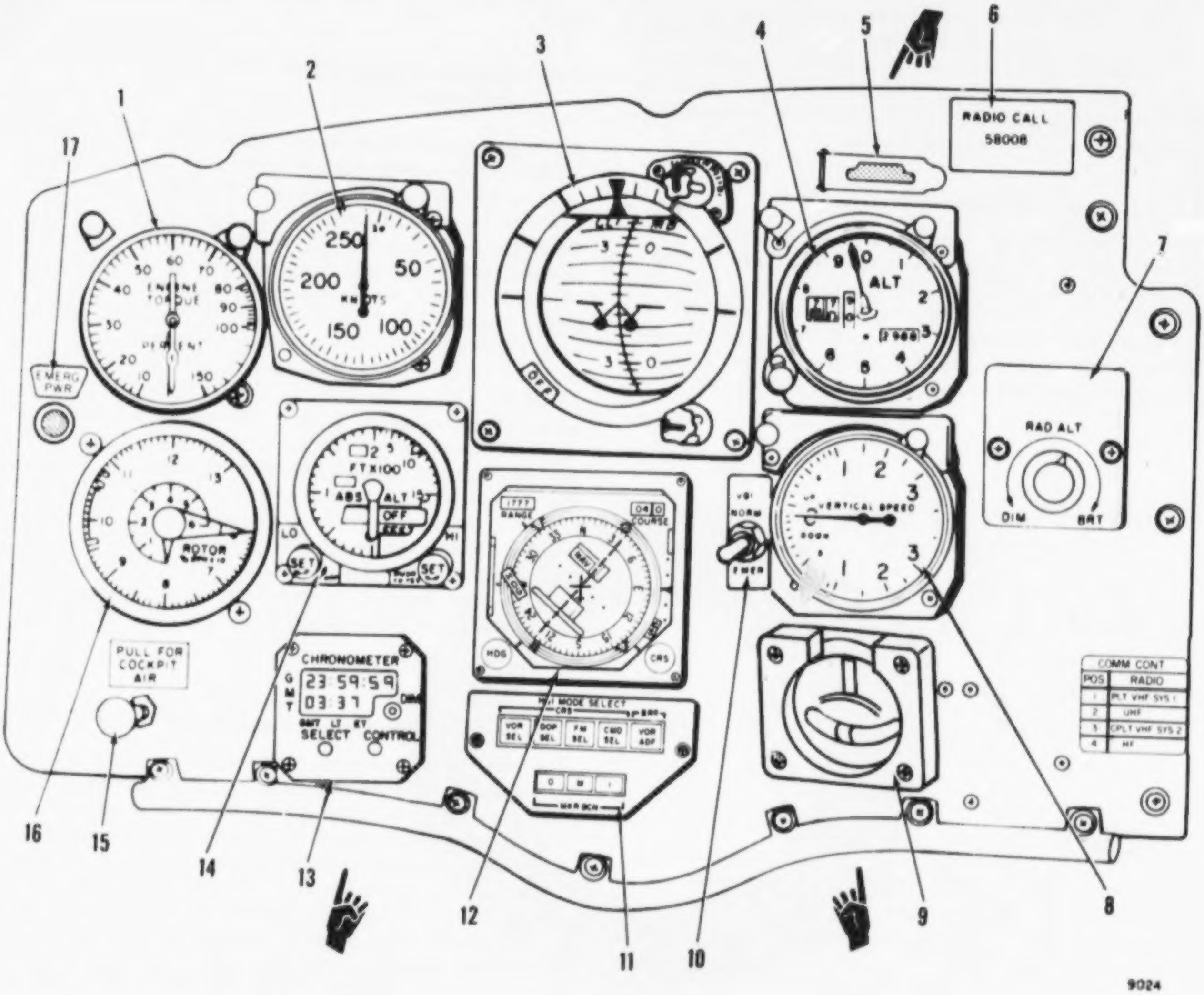
Figure 2-6.1. Armored Seats

2-24. Shoulder Harness Inertia Reel Lock Lever.

A two-position shoulder harness inertia reel lock lever is on the left side of each seat (20, figure 2-5). The lever positions are LOCKED (forward) and UNLOCKED (aft). The lock may be moved freely from one position to the other. When the lock lever is in UNLOCKED position, the reel harness cable is released to allow freedom of movement. However, the reel will automatically lock if a horizontal impact force of 2 to 3 g's is encountered. When the reel is locked in this manner, it stays locked until the lock lever is moved forward to LOCKED and then returned to UNLOCKED. When the lever is at LOCKED, the reel is manually locked so the pilot is restrained from bending forward. When a crash landing or ditching is anticipated and time permits, manual locking of the shoulder harness inertia reel provides added safety beyond the automatic feature of the inertia reel. Depending on the pilot's seat adjustment, it may not be possible to reach all switches with the inertia reel locked. Each pilot should check and adjust the shoulder harness in locked position to determine whether all switches can be reached.

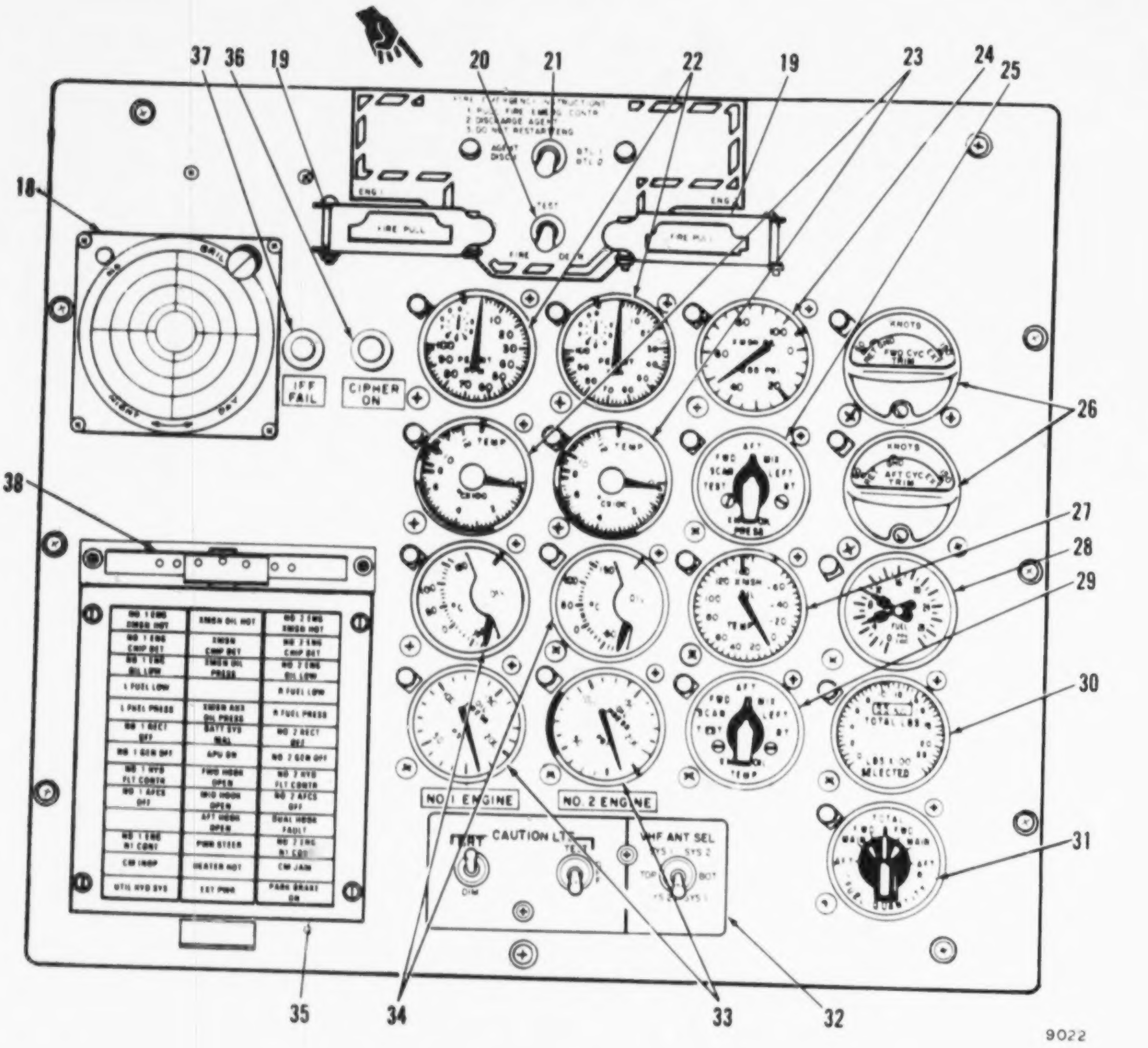
2-25. Self-Tuning Dynamic Absorbers.

The helicopter is equipped with three self-tuning dynamic absorbers. One absorber is in the nose compartment and the other two absorbers are under each pilot's seat below the cockpit floor. All three absorbers serve to maintain a minimum vibration level thru the normal operating rotor rpm range of the helicopter. The self-tuning feature of the dynamic absorber functions as follows: each dynamic absorber consists of a tuning mass suspended by springs, and electronic measuring circuit, accelerometers, counter-weights, an electrical actuator and a self-test box. The accelerometers sense and compare the vibration phases of the helicopter and the spring-mounted mass. When the measured vibration phases differ from a built-in phase relationship required to assure proper tune, the electronic circuit extends or retracts the electrical actuator to reposition the counterweights which, in turn, increases or decreases the resonant frequency of the spring-mounted mass. The dynamic absorbers are constantly being adjusted (tuned) to minimize helicopter vibration. A self-test box is in the heater compartment to provide maintenance personnel with an integral testing capability for the self-tuning feature of the dynamic absorbers. Electric power is supplied by the No. 2 ac bus thru three circuit breakers labeled VIB ABSORB-LH, CTR, and RH on the No. 2 power distribution panel.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
RADIO CALL
58008
EMERG PWR
ENGINE TORQUE PERCENT
KNOTS
ALT
VERTICAL SPEED
RAD ALT
DIM
BRT
ROTOR
FT X100
ABS ALT
OFF
SET
LO
HI
VGI
NORM
STBY
RANGE
COURSE
HDG
CRS
HSI MODE SELECT
VOR SEL
DOP SEL
FM SEL
CMD SEL
VOR ADF
CHRONOMETER
GMT
SELECT
CONTROL
PULL FOR COCKPIT AIR
COMM CONT
POS
RADIO
1 PLT VHF SYS 1
2 UHF
3 CPLT VHF SYS 2
4 HF
9024

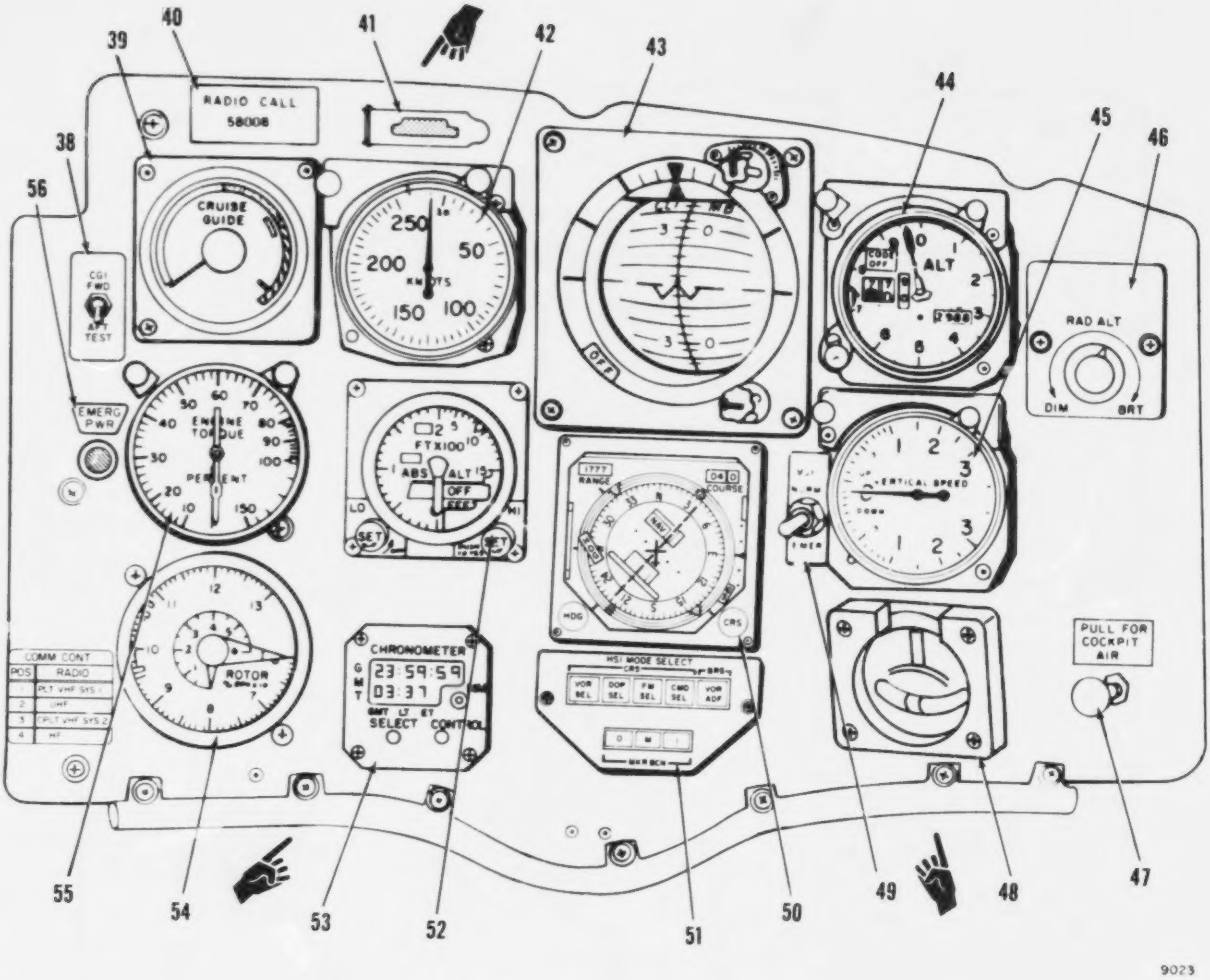
1. Torquemeter
2. Airspeed indicator
3. Attitude indicator
4. Altimeter
5. Master caution light with NVG filter
6. Radio call plate
7. Radar altimeter display dimmer
8. Vertical velocity indicator
9. Turn and slip indicator
10. Attitude indicator (VGI) switch
11. HSI mode select panel
12. Horizontal situation indicator
13. Clock
14. Radar altimeter
15. Cockpit air knob
16. Rotor tachometer
17. Emergency power caution light

Figure 2-7. Instrument Panel (Typical) (Sheet 1 of 3)


37
36
19
20
21
22
19
23
24
25
18
26
38
27
28
29
30
31
35
34
33
32
FIRE PULL
FIRE PULL
IFF FAIL
CIPHER ON
NO 1 ENGINE
NO. 2 ENGINE
CAUTION LTS
VHF ANT SEL
9022

18. Missile alert display
19. Fire control handles with NVG filters
20. Fire detector test switch
21. Fire extinguisher agent switch
22. Gas producer tachometers
23. Power turbine inlet temperature indicators
24. Transmission oil pressure indicator
25. Transmission oil pressure selector switch
26. Longitudinal cyclic trim indicators
27. Transmission oil temperature indicator
28. Fuel flow indicator
29. Transmission oil temperature selector switch
30. Fuel quantity indicator
31. Fuel quantity selector switch
32. Caution lights and vhf antenna select panel
33. Engine oil pressure indicators
34. Engine oil temperature indicators
35. Master caution panel
36. KY-28 indicator light
37. IFF caution light
38. Caution panel NVG filter

Figure 2-7. Instrument Panel (Typical) (Sheet 2 of 3)


40
41
39
42
43
44
38
45
46
56
RADIO CALL
58008
CRUISE GUIDE
CGI FWD
AFT TEST
KNOTS
250
200
150
100
50
ALT
RAD ALT
DIM
BRT
EMERG PWR
ENGINE TORQUE PERCENT
FT X100
ABS
ALT
OFF
LO
HI
SET
RANGE
COURSE
HDG
CRS
VERTICAL SPEED
UP
DOWN
COMM CONT
POS
RADIO
PLT VHF SYS 1
UHF
CPLT VHF SYS 2
HF
ROTOR
CHRONOMETER
GMT
23:59:59
03:31
SELECT
CONTROL
HSI MODE SELECT
VOR SEL
DOP SEL
FM SEL
CMD SEL
VOR ADF
MKR BCN
PULL FOR COCKPIT AIR
55
54
53
52
51
50
49
48
47
9023

38. Cruise guide test switch
39. Cruise guide indicator
40. Radio call plate
41. Master caution light with NVG filter
42. Airspeed indicator
43. Attitude indicator
44. AIMS altimeter
45. Vertical velocity indicator
46. Radar altimeter display dimmer
47. Cockpit air knob
48. Turn & slip indicator
49. Attitude indicator (VGI) switch
50. Horizontal situation indicator
51. HSI mode select panel
52. Radar altimeter
53. Clock
54. Rotor tachometer
55. Torquemeter
56. Emergency power caution light

Figure 2-7. Instrument Panel (Typical) (Sheet 3 of 3)

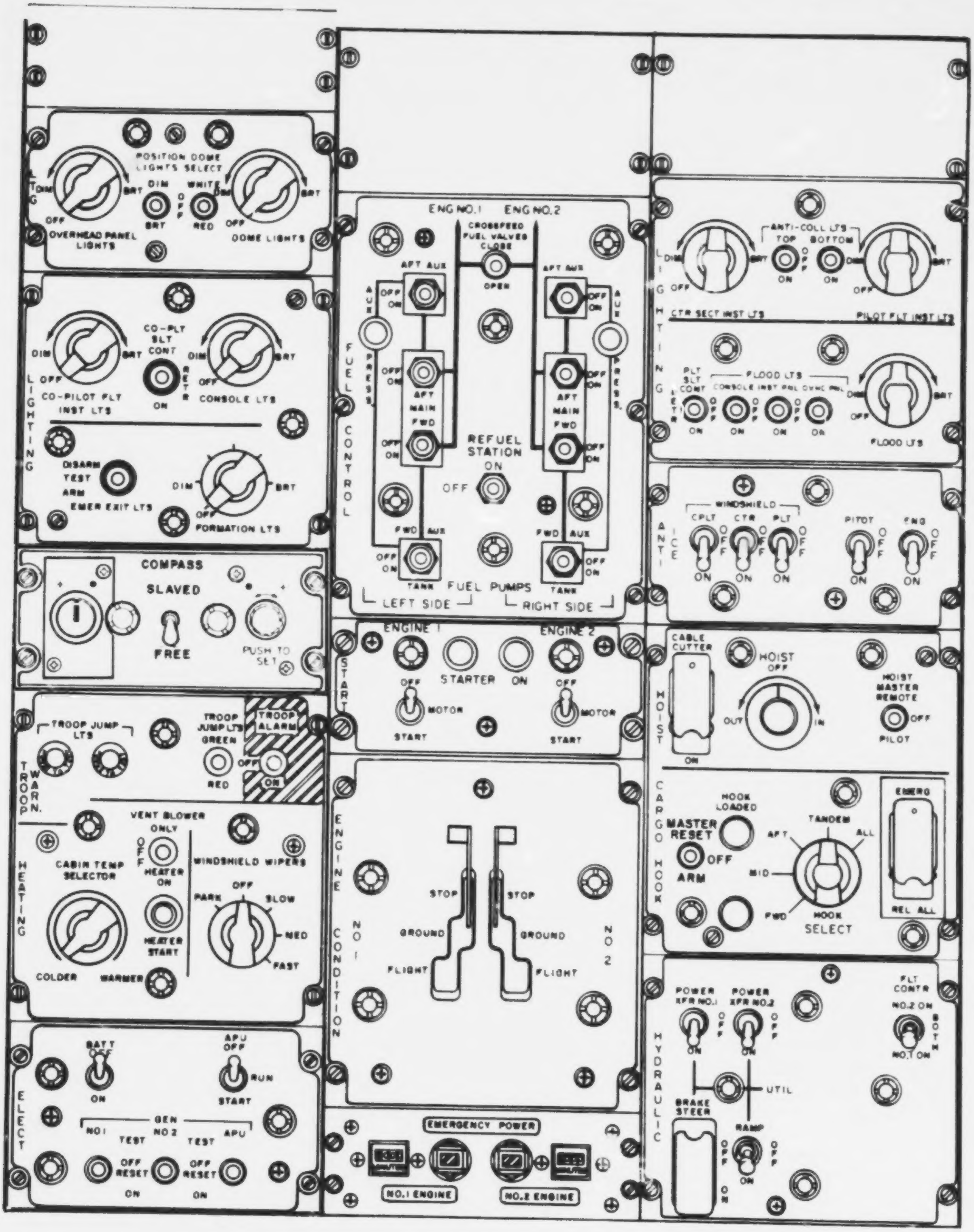

POSITION DOME LIGHTS SELECT
DIM
BRT
OFF
WHITE
RED
OVERHEAD PANEL LIGHTS
DOME LIGHTS
LIGHTING
CO-PLT SLT CONT
RETR
ON
CO-PILOT FLT INST LTS
CONSOLE LTS
DISARM
TEST
ARM
EMER EXIT LTS
FORMATION LTS
COMPASS
SLAVED
FREE
PUSH TO SET
TROOP JUMP LTS
TROOP JUMP LTS GREEN
RED
TROOP ALARM
ON
TROOP WARN.
VENT BLOWER ONLY
HEATER ON
HEATER START
CABIN TEMP SELECTOR
COLDER
WARMER
HEATING
WINDSHIELD WIPERS
PARK
SLOW
MED
FAST
BATT
APU OFF
RUN
START
GEN
NO 1
TEST
NO 2
APU
OFF RESET
ELECT
ENG NO.1
ENG NO.2
CROSSFEED FUEL VALVES CLOSE
OPEN
AFT AUX
AUX PRESS.
FUEL CONTROL
AFT MAIN FWD
REFUEL STATION
FWD AUX
TANK
FUEL PUMPS
LEFT SIDE
RIGHT SIDE
ENGINE 1
ENGINE 2
STARTER
START
MOTOR
ENGINE CONDITION
NO 1
NO 2
STOP
GROUND
FLIGHT
EMERGENCY POWER
NO.1 ENGINE
NO.2 ENGINE
ANTI-COLL LTS
TOP
BOTTOM
CTR SECT INST LTS
PILOT FLT INST LTS
FLOOD LTS
CONSOLE INST PNL OVHD PNL
PLT SLT CONT
FLOOD LTS
WINDSHIELD
CPLT
CTR
PLT
PITOT
ENG
ANTI ICE
CABLE CUTTER
HOIST
OUT
IN
HOIST MASTER REMOTE
PILOT
HOOK LOADED
MASTER RESET
ARM
CARGO HOOK
TANDEM
AFT
ALL
MID
FWD
HOOK SELECT
EMERG
REL ALL
POWER XFR NO.1
POWER XFR NO.2
FLT CONTR
NO.2 ON
BOTH
NO.1 ON
UTIL
BRAKE STEER
RAMP
HYDRAULIC
11964

Figure 2-8. Overhead Switch Panel (Interim NVG)

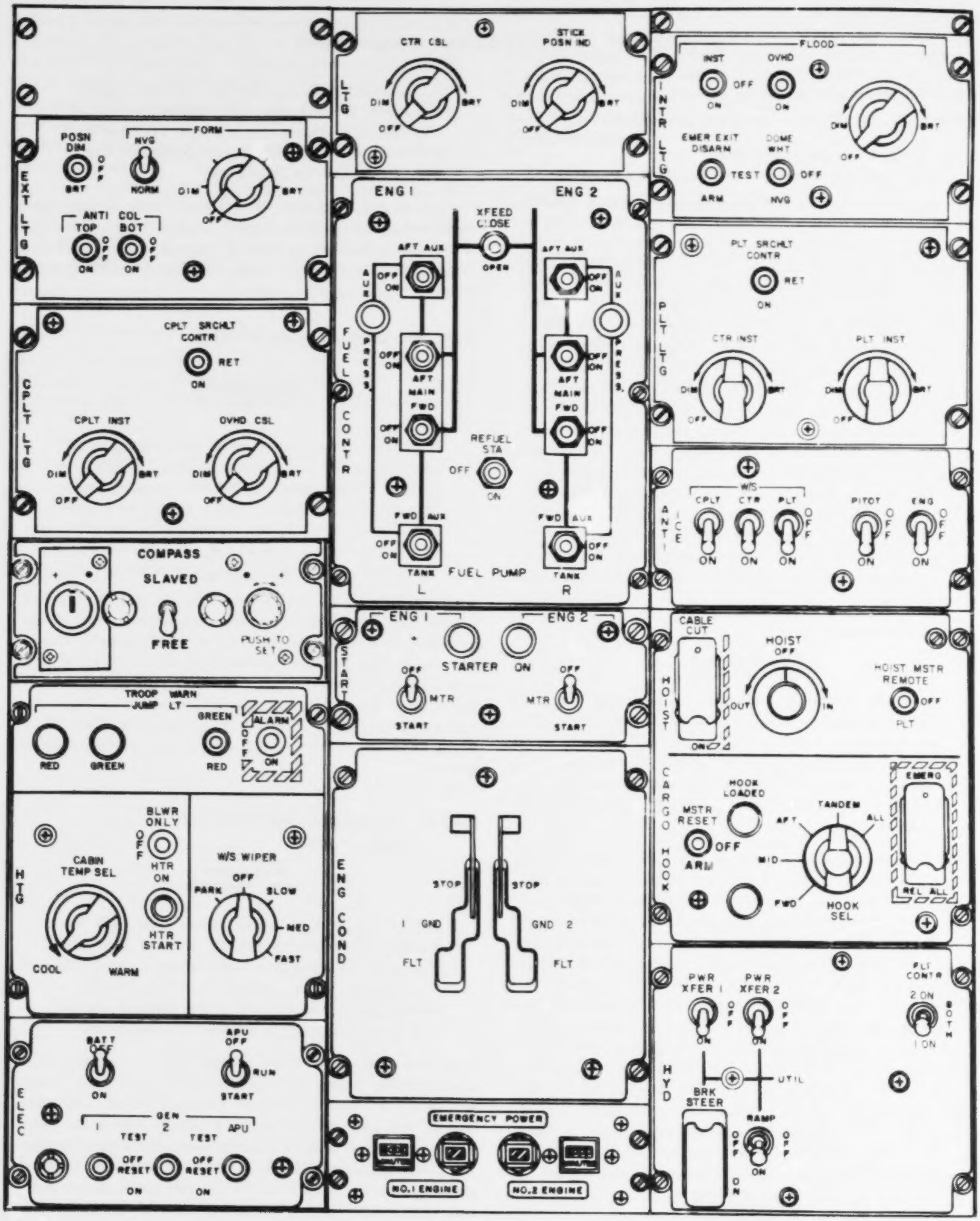

LTG
CTR CSL
DIM
BRT
OFF
STICK POSN IND
DIM
BRT
OFF
INTR LTG
FLOOD
INST
OFF
ON
OVHD
ON
DIM
BRT
OFF
EMER EXIT DISARM
TEST
ARM
DOME WHT
OFF
NVG
EXT LTG
POSN DIM
OFF
BRT
FORM
NVG
NORM
DIM
BRT
OFF
ANTI COL
TOP
OFF
ON
BOT
OFF
ON
FUEL CONTR
ENG 1
ENG 2
XFEED CLOSE
OPEN
AFT AUX
OFF
ON
AUX PRESS
AFT MAIN FWD
REFUEL STA
OFF
ON
FWD AUX
TANK
FUEL PUMP
L
R
PLT LTG
PLT SRCHLT CONTR
RET
ON
CTR INST
PLT INST
DIM
BRT
OFF
CPLT LTG
CPLT SRCHLT CONTR
RET
ON
CPLT INST
OVHD CSL
DIM
BRT
OFF
ANTI ICE
W/S
CPLT
CTR
PLT
PITOT
ENG
OFF
ON
COMPASS
SLAVED
FREE
PUSH TO SET
START
ENG 1
ENG 2
STARTER
ON
OFF
MTR
START
HOIST
CABLE CUT
ON
HOIST
OFF
OUT
IN
HOIST MSTR
REMOTE
OFF
PLT
TROOP WARN JUMP LT
RED
GREEN
GREEN
RED
ALARM
OFF
ON
ENG COND
STOP
1 GND
GND 2
FLT
CARGO HOOK
HOOK LOADED
MSTR RESET
OFF
ARM
TANDEM
AFT
ALL
MID
FWD
HOOK SEL
EMERG
REL ALL
HTG
CABIN TEMP SEL
COOL
WARM
BLWR ONLY
OFF
HTR ON
HTR START
W/S WIPER
OFF
PARK
SLOW
MED
FAST
HYD
PWR XFER 1
PWR XFER 2
OFF
ON
FLT CONTR
2 ON
BOTH
1 ON
UTIL
BRK STEER
ON
RAMP
OFF
ON
ELEC
BATT
OFF
ON
APU
OFF
RUN
START
GEN
1
TEST
2
TEST
APU
OFF
RESET
ON
EMERGENCY POWER
NO.1 ENGINE
NO.2 ENGINE
01

Figure 2-8.1. Overhead Switch Panel (NVG)

SECTION II EMERGENCY EQUIPMENT

2-26. Emergency Procedures.

Refer to Chapter 9 for all emergency procedures.

2-27. Engine Compartment Fire Extinguisher System.

The engine compartment fire extinguisher system (figure 2-9) enables the pilot or the copilot to extinguish a fire in either engine compartment only. It is not designed to extinguish internal engine fires. The system consists of two fire control handles, a fire extinguisher agent switch, a fire detector test switch on the instrument panel, and two extinguisher agent containers on the overhead structure at stations 482 and 502. The containers are partially filled with monobromotrifluoromethane ($CBrF_3$ or CF_3BR) and pressurized with nitrogen. (Refer to table 2-1 for the range of engine fire extinguisher pressures.) The agent in one or both of the containers can be discharged into either engine compartment. Selection of the compartment is made by pulling the appropriate fire control handle. In figure 2-9, the NO. 1 ENGINE fire control handle has been pulled. Selection of the container is made by placing the fire extinguisher agent switch in the appropriate position. In figure 2-9, BOTTLE NO. 1 has been selected. Decontamination of the engine is not required when the extinguisher has been discharged.

2-28. Fire Control Handles.

WARNING

Improper handling of the NVG filter holder on the fire handle warning light cover may cause the fire handle to be pulled unintentionally, resulting in inadvertent engine shutdown. Do not use sudden or excessive force when rotating the fire handle filter holder from the closed to the open position.

Two control handles for the engine fire extinguisher system (figure 2-9) are on the center section of the instrument panel. Each handle contains two warning lights and control switches that close the engine fuel shutoff valve and arm the fire extinguishing system circuits. The warning lights are enclosed in a cover with a hinged NVG filter holder on the front. When one of the handles is pulled out, the respective engine fuel shutoff valve is closed and the fire extinguisher agent switch is armed for selection and discharge of either fire bottle by selecting either momentary position on the agent discharge switch. After depletion of the charge in the initially selected bottle, the remaining bottle can be discharged to the same engine compartment by selecting the opposite position on the bottle selector switch. The other fire control handle performs the same function for its respective engine compartment.

CAUTION

If there is a fire in both engine compartments, do not pull both fire control handles simultaneously. Extinguish fire in one compartment only as described above. Leave the fire control handle out after fire has been extinguished. Proceed, in a like manner, to extinguish fire in the other engine compartment.

Control of the discharge of either or both bottles is as described above. Electric power is supplied from the 28-volt dc No. 1 and No. 2 essential buses thru FIRE EXT circuit breakers on the No. 1 and No. 2 power distribution panels.

2-29. Fire Control Handle Warning Lights.

WARNING

If the fire control handle fire warning lights are covered by the NVG filters during daylight operation, illumination of the fire warning lights may not be apparent in the event of an engine fire. Do not operate the aircraft with the NVG filters covering or obscuring the fire warning lights unless night vision goggles are being used.

Two warning lights are contained in the end of each fire control handle. When an engine compartment fire occurs on either side, the respective pair of warning lights comes on. Each fire handle is marked FIRE-PULL-FUEL SHUTOFF. Power is supplied for each pair of lights from the corresponding No. 1 or No. 2 115-volt ac bus thru circuit breakers labeled ENGINE NO. 1 and ENGINE NO. 2 FIRE DET on the No. 1 and No. 2 power distribution panels.

2-29.1. Fire Control Handle Warning Light Covers.

WARNING

Before flying the aircraft ensure that each fire handle filter holder can be rotated from the closed to the open position without causing the fire handle to be pulled. If a fire handle is inadvertently pulled, fuel to the affected engine will be shut off and the engine will shut down.

Each fire control handle warning light is enclosed in a cover. A filter holder with an NVG filter is attached to one end of the fire handle cover by a hinged fitting. The other end of the filter holder forms a tab by which the filter holder and filter may be rotated about the hinged fitting. For NVG operations, the filter holder is rotated to a closed position over the front of the fire handle cover. In this position, the fire handle fire warning light is NVG compatible. For normal operations, the filter holder is rotated from the closed position to the fully open position. In this position, the fire handle warning light will be red.

2-30. Fire Extinguisher Agent Switch.

A three-position fire extinguisher agent switch (figure 2-9) is above the fire control handles on the instrument panel. The lever-lock momentary switch positions are BOTTLE NO. 1, neutral, and BOTTLE NO. 2. When one of the fire control handles is pulled OUT and the fire extinguisher agent switch is set in BOTTLE NO. 1 position, the agent is discharged from the No. 1 container into the selected engine compartment. If the switch is set in BOTTLE NO. 2 position in the above case, agent from No. 2 container will be discharged into the same engine compartment. Only two fire extinguisher agent containers are provided. If the agent from both containers is used in combating a fire in one engine compartment, agent will not be available should a fire occur in the other engine compartment.

2-31. Fire Detector Test Switch.

The fire detector test switch (figure 2-9) is below the fire extinguisher agent switch on the center section of the instrument panel and is labeled FIRE DETECTOR—TEST. The two-position toggle switch is spring-loaded to FIRE DETECTOR. The switch is used to check the operation of the fire detection system. When the switch is actuated, relays in both controls units close and the lights in both fire control handles come on. Power to operate the test circuit is supplied by the 28-volt dc essential bus thru the CAUTION PNL circuit breaker on the No. 1 power distribution panel.

2-32. Hand Fire Extinguishers.

WARNING

> Avoid prolonged exposure (5 minutes or more) to high concentrations of fire extinguishing agent and its decomposition products because of irritation to the eyes and nose. Adequate respiratory and eye relief from excessive exposure should be sought as soon as the primary fire emergency permits. Use of oxygen for personnel is recommended.

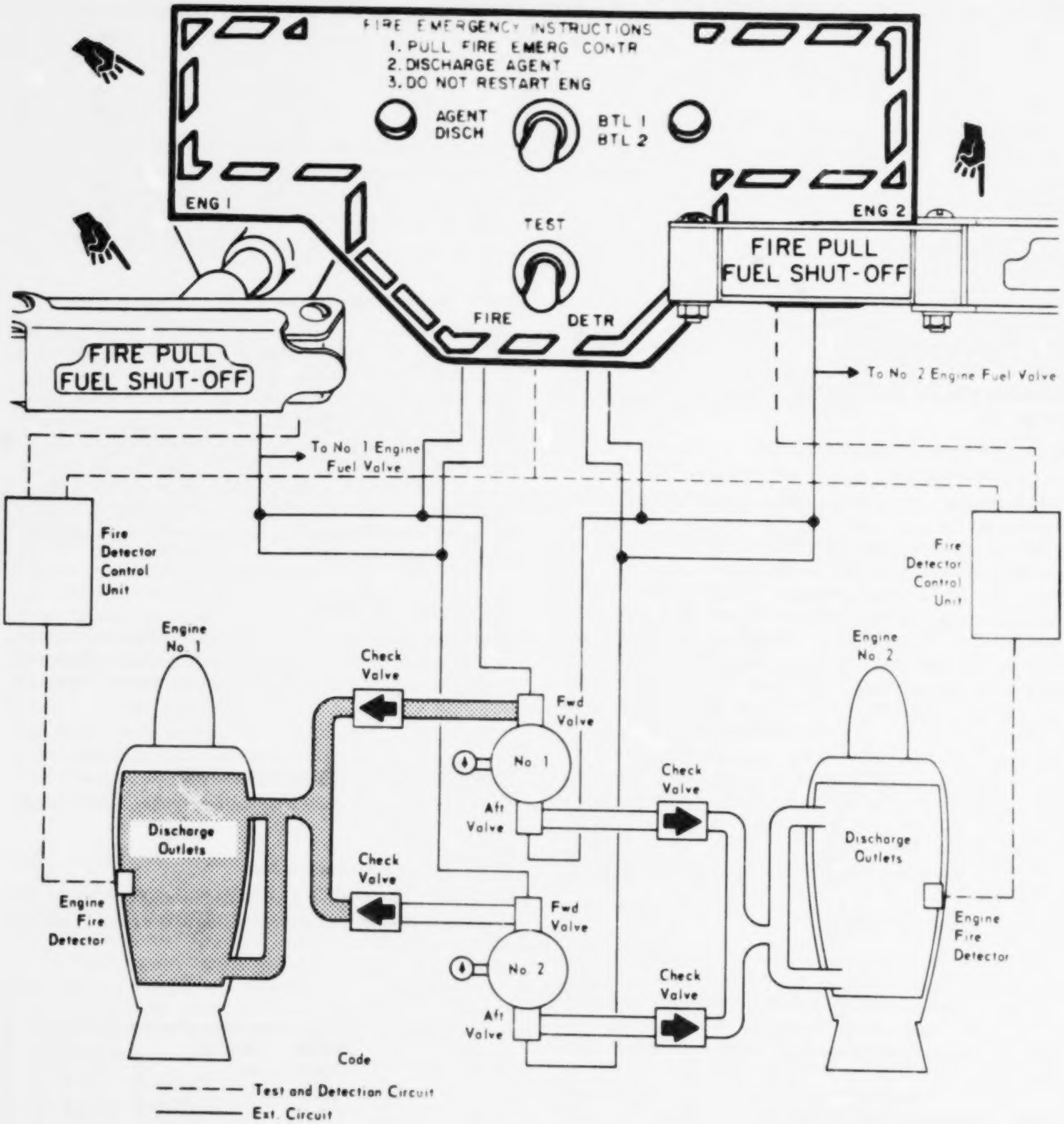

FIRE EMERGENCY INSTRUCTIONS
1. PULL FIRE EMERG CONTR
2. DISCHARGE AGENT
3. DO NOT RESTART ENG
AGENT DISCH
BTL 1
BTL 2
ENG 1
ENG 2
TEST
FIRE
DETR
FIRE PULL FUEL SHUT-OFF
FIRE PULL FUEL SHUT-OFF
To No. 2 Engine Fuel Valve
To No. 1 Engine Fuel Valve
Fire Detector Control Unit
Fire Detector Control Unit
Engine No. 1
Engine No. 2
Check Valve
Check Valve
Check Valve
Check Valve
Fwd Valve
Aft Valve
Fwd Valve
Aft Valve
No. 1
No. 2
Discharge Outlets
Discharge Outlets
Engine Fire Detector
Engine Fire Detector
Code
Test and Detection Circuit
Ext. Circuit
9025

Figure 2-9. Engine Compartment Fire Detection and Extinguishing System (Typical)

Table 2-1. Engine Compartment Fire Extinguisher Pressures

AMBIENT TEMPERATURE (C)	MINIMUM INDICATION (PSI)	MAXIMUM INDICATION (PSI)
-54°	271	344
-51°	275	350
40°	292	370
-29°	320	400
-18°	355	437
-7°	396	486
4°	449	540
15°	518	618
27°	593	702
38°	691	784
52°	785	902

Three portable 6.3 pound capacity hand fire extinguishers are provided in the helicopter. One is in the cockpit, on the floor to the right of the pilot's seat. Two hand fire extinguishers are in the cabin section: one on the forward bulkhead and one in the rear, just forward of the ramp on the left side.

2-33. Emergency Troop Alarm and Jump Lights.

Two emergency troop alarm and jump light boxes are in the cargo compartment. The forward box is on the bulkhead above the avionic equipment shelves and the aft box is on the left side of the fuselage above the ramp at station 575. Each box has an electric bell in the center with a red light fixture on one side and a green light fixture on the other side. The emergency troop alarm and jump lights have several functions. The emergency troop alarm can be used to notify passengers and crew with predetermined signals in time of emergency. The jump lights can be used to notify the flight engineer during airborne delivery operations, and also to alert the troop commander during paratroop drop missions. Power to operate and control the emergency troop alarm and jump lights is supplied by the essential dc bus thru two circuit breakers labeled TROOP ALARM BELL and JUMP LT, on No. 2 power distribution panel. Refer to paragraph 9-4 for standard use of the troop alarm.

2-34. Troop Alarm Switch.

A two-position toggle switch on the TROOP WARN panel (figure 2-10) of the overhead switch panel is labeled TROOP ALARM with positions marked OFF and ON. Moving the troop alarm switch to ON rings the bell continuously at both stations until the switch is moved to OFF.

2-35. Troop Jump Lights Switch.

A three-position toggle switch on the TROOP WARN panel (figure 2-10) of the overhead switch panel is labeled JUMP LT with positions marked GREEN, OFF, and RED. When the switch is set to GREEN, the green lights on the emergency troop and jump light box, at both stations, and the troop jump lights on the overhead switch panel come on. When the switch is set to RED, the red lights come on. OFF position turns off both sets of lights.

2-36. Troop Jump Lights.

Two troop jump lights on the TROOP WARN panel (figure 2-10) on the overhead switch panel are provided to give the pilots a visual indication of the troop jump light selected. One light is provided for each color selection and comes on when the respective light is selected. On helicopters with interim NVG provisions, the lights dim when the CAUTION LIGHTS switch on the console is moved to DIM. On helicopters with the final NVG configuration, the brightness of the lights is controlled by the PLT INST rotary control switch on the right side of the overhead panel.

2-37. First Aid Kits.

Seven aeronautic first aid kits are installed in the helicopter. One kit is in the passageway between the cockpit and cabin and six are in the cabin fuselage section, three on each side.

2-38. Emergency Entrances and Exits.

See figure 9-2 for information on emergency entrances and exits.

2-39. Emergency Escape Axe.

An emergency escape axe is provided and is slightly forward of station 200, on the right side of the cargo compartment.

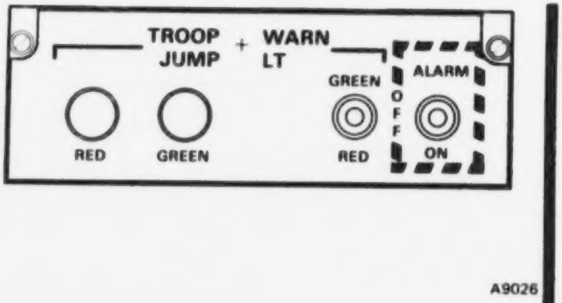


Figure 2-10. Troop Warning Panel (Typical)

SECTION III ENGINES AND RELATED SYSTEMS

2-40. Engines.

The CH-47D is powered by two T55-L-712 engines. The engines are housed in separate nacelles mounted externally on each side of the aft pylon. The T55-L-712 engine has the capability to produce emergency power on pilot demand. See Performance Charts in Chapter 7.

2-41. Each engine has two main sections: a gas producer section and a power turbine section. The gas producer supplies hot gases to drive the power turbine. It also mechanically drives the engine accessory gearbox. The power turbine shaft extends coaxially thru the gas producer rotor and rotates independently of it. The gas producer section and the power turbine section are connected by only the hot gases which pass from one section to the other. During engine starting, air enters the engine inlet and is compressed as it passes thru seven axial stages and one centrifugal stage of the compressor rotor. The compressed air passes thru a diffuser. Some of the air enters the combustion chamber where it is mixed with start fuel. The mixture is ignited by four igniter plugs. Some of the air is directed to the fuel nozzles. After the engine is started, it continues to operate on metered fuel supplied to the fuel nozzles. Hot expanding gases leave the combustion chamber and drive a two-stage gas producer turbine. Energy from the combustion gases also drives the two-stage power turbine, which drives the power turbine shaft to the engine transmission. The engine lubrication system has an integral oil tank which is inside the air inlet housing and is serviced with 14 quarts. (Refer to table 2-3.)

2-42. Engine Inlet Screens.

An engine inlet screen which minimizes foreign object damage (FOD) is installed on each engine. The reduction in engine power available with screens installed is negligible. The engine inlet screens have bypass panels. These two panels are on the aft end of each screen. Quick release fasteners attach the panels to the screens. For information on use of bypass panels, refer to Chapter 5, Section VII.

2-43. Engine Anti-Icing.

The engine air inlet fairing and engine drive shaft fairing receive anti-icing protection from two sources: hot air ducted to the fairings from the engine compressor and thermal radiation produced by the oil tank in the engine inlet housing. An electrically operated fairing hot air valve is positioned on the top right side of the engine compressor housing directly behind, and to the right of the starter. The valve is secured on one end to the engine air bleed gallery and at the other end by a tube assembly secured to the fairing. When open, the valve allows hot air to flow from the compressor diffuser section to the internal passages of the fairing. This inhibits ice formation on the inlet fairing and engine drive shaft fairing. Additional anti-ice protection is provided by thermal radiation from the inlet housing. The hot oil in the oil cavity of the inlet housing warms the air as it passes into the engine inlet. When the engine anti-ice switch is moved to ON, anti-icing operation is usually indicated by the following: a rise in engine temperature (PTIT), a drop in N1 speed and then a return to original speed, and an increase in engine oil temperature. In addition, a reduction in power can occur.

2-44. Engine Anti-Ice Switch. A two-position toggle switch on the anti-ice control panel (figure 2-8) of the overhead switch panel, controls the fairing hot air valves. The ENG ANTI-ICE ON-OFF switch electrically positions the engine hot air valves. When the switch is at ON, the engine hot air valves are spring loaded open. When the switch is at OFF, the engine hot air valves are electrically powered closed. If electrical failure occurs, the valves remain open in anti-icing mode. The switch receives power from No. 1 and No. 2 28-volt dc buses thru circuit breakers on the No. 1 and No. 2 power distribution panels marked ENG ANTI-ICE NO. 1 and NO. 2.

2-45. Normal Operation — Engine Anti-Icing. The ENG ANTI-ICE NO. 1 and NO. 2 circuit breakers shall be in during operation at all ambient air temperatures. If the circuit breakers are out, anti-icing becomes continuous and a reduction in engine power may occur. For information on use of bypass panels, refer to Chapter 5.

2-46. Engine Power Control System.

Each engine is controlled by a separate power control system which includes cockpit controls and an engine fuel control unit. Each system provides automatic control of engine gas producer rotor speed and power turbine speed in response to any setting of the engine controls selected by the pilot. Engine gas producer rotor speed (N1) and power turbine speed (N2) are controlled by the fuel control unit, which varies the amount of fuel delivered to the engine fuel nozzles. During normal operation, the fuel control unit automatically prevents power changes from damaging the engine. Fuel flow is automatically monitored to compensate for changes in outside air temperature and compressor discharge pressure.

2-47. Engine Fuel Control Units. Each engine fuel control unit contains a single element fuel pump, a gas producer speed governor, a power turbine speed governor, an acceleration-deceleration control, a fuel flow limiter, a fuel control fuel shutoff valve, and a main metering valve. Two levers are mounted on the fuel control unit: a gas producer (N1) lever and a power turbine (N2) lever. Output power of the power turbine (a function of speed and torque) is restricted by limiting the maximum fuel flow to the gas producer. Maximum gas producer rotor speed is set by the engine condition levers in the cockpit. The engine condition lever electromechanically positions the gas producer lever, which controls the fuel control fuel shutoff valve and the operating level of the gas producer. During flight, the engine condition lever is left at FLIGHT position and the output shaft speed is regulated by the power turbine speed (N2) governor. The power turbine lever is electromechanically positioned by the engine beep trim switches, thrust control, and emergency engine trim switches. Output shaft torque is limited by the fuel flow limiter, which limits the maximum fuel flow. The position of the main metering valve is determined by the gas producer speed governor, power turbine speed governor, the acceleration-deceleration control, or the fuel flow limiter, depending on engine requirements at that time. The governor or the control unit demanding the least fuel flow overrides the other in regulating the metering valve.

2-48. Speed Governing. The power turbine speed governor senses the speed of the power turbine and regulates the amount of fuel which is supplied to the gas producer. This slows down or speeds up the gas producer rotor so that power turbine and rotor system speed remains nearly constant as loads vary. At minimum rotor blade pitch, the amount of power being supplied by either engine is at minimum. As pitch is increased, more power is required from the engine to maintain constant rotor speed and power turbine speed (N2) starts to decrease. The power turbine speed governor senses the decrease of N2 RPM and increases the flow of fuel to the gas producer. This creates more hot gases for the power section of the engine. Decreasing pitch causes N2 to increase. The power turbine governor senses the increase and reduces the flow of fuel to the gas producer, thus decreasing the amount of hot gases for the power turbine. The power turbine speed governor allows the power turbine output speed to decrease (droop) approximately 10 percent when the power loading varies from minimum to full load. This is minimized by a droop eliminator linked to the thrust control rod. The droop eliminator automatically changes the power turbine lever to compensate for droop as pitch is increased or decreased. Another type of droop, which is only transient, occurs as a result of the time required for the engine to respond to changing loads due to N2 governor lag.

2-49. Engine Condition Levers. Two engine condition levers (ECL), one for each engine, are on the ENGINE CONDITION panel (fig. 2-11) on the overhead switch panel. Each lever is used to select appropriate fuel flow rates for GROUND, FLIGHT, and STOP (engine shutdown). Operation of the ECL moves a position sensor resulting in movement of the N1 actuator. If the N1 actuator fails to align to the position selected by the ECL, or the ECL is not in a detent, the N1 CONT caution light will illuminate. The actuator mechanically operates a lever, which controls the fuel control fuel shutoff valve and the operating speed of the gas producer. The engine condition lever positions are STOP, GROUND, and FLIGHT. Each lever is spring-loaded outboard and is inhibited by lock gates. The engine condition lever must be at GROUND before the engine will start. When a condition lever is advanced from STOP to GROUND, power is then supplied to the electromechanical actuator which establishes an appropriate fuel flow rate at ground idle. The speed of the gas producer with the lever at GROUND should be 60 to 63 percent N1. When an ECL is moved to FLIGHT, the engine is operating within the N2 governing range, unless the engine is "topped out" at which time it goes back to N1 governing. The N2 governor then takes control to maintain selected rotor rpm in response to the engine beep trim switches and collective pitch changes. When an ECL is moved to STOP, the gas producer lever closes the fuel control fuel shutoff valve which stops fuel flow to the gas producer. The engine condition levers and gas producer actuators allow the pilot to proportionally control acceleration of the gas producer from STOP to FLIGHT. Interlock switches within the ENGINE CONDITION panel and N1 actuators turn on the N1 CONT caution light when the N1 actuator position does not agree with ECL position in STOP, GROUND, or FLIGHT. Each electrical

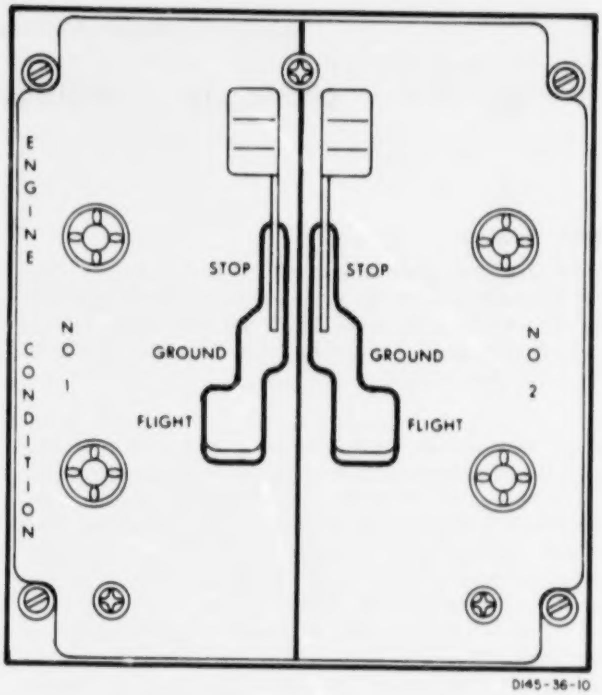


Figure 2-11. Engine Condition Panel

system is completely separate and a failure in one system will not affect the other. A built-in mechanical brake holds the actuator at its last selected position if loss of electrical power occurs. ECL friction is provided to reduce the possibility of overtorquing the engine transmissions by resisting movement of the engine condition levers. The ECL friction brake cannot be adjusted by the pilot and a force of 4 to 5 pounds on the engine condition levers is needed to move them. Electrical power is supplied by the 28-volt dc essential buses thru NO. 1 and NO. 2 COND CONT circuit breakers on the power distribution panels.

CAUTION

When adjusting controls or switches on the overhead switch panel, make sure gloves or sleeves do not catch and inadvertently move the engine condition levers.

2-50. Engine N1 Control Caution Lights. Two engine control caution lights are on the master caution panel (figure 2-46). They are marked NO. 1 ENG N1 CONT and NO. 2 ENG N1 CONT. The lights normally come on when the engine condition levers or the N1 actuators are at an intermediate position between STOP, GROUND, or FLIGHT. They go out when ECL and N1 actuator positions agree. However, they remain on if a component of the system (actuator, control box, or condition panel) has failed in other than a detent position. The 28-volt dc essential bus supplies electrical power to the caution lights. A circuit breaker marked CAUTION PNL on the No. 1 power distribution panel protects the caution light circuit.

2-51. Normal Engine Beep Trim Switches. Two momentary switches for engine beep trim are on the auxiliary switch bracket of each thrust control (figure 2-21). Both switches have three positions: RPM INCREASE, RPM DECREASE, and a normal position. One switch, marked NO. 1 & 2, is normally used to select desired rotor rpm. Holding the switch forward increases rotor rpm. Holding the switch aft decreases rotor rpm. When the switch is released, it returns to the center or normal position. The switch electrically controls both power turbines by movement of the N2 actuator thru each engine power turbine control box. The second beep trim switch, marked NO. 1, will affect only the No. 1 engine. This switch is used to match engine loads which is indicated by dual torquemeters. Because NO. 1 engine beep switch will also change rotor rpm, the procedure for matching engine load requires that NO.1 & 2 beep switch be used in conjunction with NO. 1 engine beep switch. When NO. 1 engine beep switch is moved forward (RPM INCREASE), the torque of No. 1 engine increases. At the same time rotor rpm increases, even though No. 2 engine torque decreases slightly. Moving NO. 1 & 2 engine beep trim switch aft (RPM DECREASE) causes both engine torques to decrease and reduce rotor rpm. If torques are still not matched, this procedure is continued until torques are matched and desired rotor rpm is attained. The opposite action occurs when NO. 1 engine beep switch is moved aft. The engine beep trim switches should not be used during power changes initiated by thrust rod movement because rotor rpm droop should only be momentary. The engine beep trim system adjusts engine rpm only if the respective engine condition lever is at FLIGHT. At STOP or GROUND, it is possible to move the power turbine lever by moving the engine beep trim switches to DECREASE or INCREASE: but in either case, engine rpm will not be affected because the engine is not operating in the N2 governing range. Power to operate the beep trim system is supplied by the 28-volt dc and the 115-volt ac buses. Power to operate the power turbine actuators is dc voltage. This dc voltage is derived from the 115-volt ac primary bus after the ac is transformed and rectified by the engine power turbine control box. Ac circuit breakers are marked ENGINE NO. 1 and NO. 2 TRIM & TIMER. Dc circuit breakers are marked ENGINE NO. 1 and NO. 2 TRIM. The circuit breakers are on their respective power distribution panels.

NOTE

No two engines provide matched performance with regard to torque, rpm, ptit or fuel flow. With torque matched all other parameters may not be matched.

2-52. Normal ENGINE TRIM System Disable Switches. Two guarded switches are on the emergency engine trim panel on the console (figure 2-6). The switches permit the pilot to disable either or both normal beep trim systems. This prevents unwanted signals from the normal beep trim system from interfering with the operation of the emergency engine trim system. (Refer to para 2-53.) Each switch is marked AUTO and MANUAL. When either switch is at MANUAL, the respective normal beep trim system is disabled (115-volt ac from the ac bus to the engine power turbine control box is interrupted). When the switch is at AUTO (cover down), the normal beep trim system is functional (115-volt ac from the ac bus is reconnected to the associated engine power turbine control box). (Refer to para 9-20 and 9-21 for emergency engine trim operation.)

2-53. Emergency Engine Trim Switches.

CAUTION

Engine response is much faster when rotor rpm is controlled with emergency engine beep trim system. It is possible to beep the rotor speed below safe operating speed and low enough to disconnect the generators from the buses. The generators are disconnected at 85% to 82% rotor rpm after a 3 to 7 second time delay.

Two momentary switches for emergency engine trim are on the emergency engine trim panel on the console (fig. 2-6). Each switch is used to change the power turbine speed of its respective engine if the power turbine control box (normal beep trim system) malfunctions. When the normal trim system fails, the droop eliminator also fails to function. Each switch has three positions: INC, DECR, and a spring-loaded center position. When one of the switches is held at INC, power from the 28-volt dc essential bus goes directly to the respective power turbine actuator and increases the lever setting and the power turbine speed. When the switch is held at DECR, the lever setting is decreased, and the power turbine speed is decreased. The emergency engine trim switches are to be used when the normal beep trim system is disabled. If one of the switches is used while the respective power turbine control box is functioning normally, the power turbine actuator setting will temporarily change but will return to its original setting when the switch is released. Power to operate the emergency engine beep trim switches and actuators is supplied by the 28-volt essential dc bus thru the No. 1 and No. 2 EMERG ENG TRIM circuit breakers on respective power distribution panel.

2-54. Emergency Power System.

CAUTION

To prevent damage, monitor the torque and the PTIT indicators when operating with emergency power. Failure to observe these indicators could result in serious damage to the drive train and engines. An aircraft log book entry is required each time emergency power indicator flag is tripped.

An emergency power system is included with T55-L-712 engines. With the emergency power system, increased power is available on pilot demand and is actuated by raising the thrust control into the emergency power range. (Refer to Chapter 5 for limitation on its use.) When fuel flow increases to the point where power turbine inlet temperature is 890° to 910°C, the EMERG PWR lights will come on. If temperature is maintained in this range for more than 5 seconds, the emergency power indicator will display a black-and-white flag, and the emergency power timer will start. When thrust is reduced below the emergency power level, the emergency power lights will go out and the timer will stop. However, the emergency power indicator will continue to display the black-and-white flag. The flag can be reset on the ground only, using a switch in the nose compartment.

WARNING

Prior to flight, be sure the two topping stops are in their stowed position on the right side of the console. If the stops are not stowed, be sure the stops are not installed on the fuel controls before you start the engine. Failure to check may result in inability to achieve emergency power in an emergency.

Topping stops are stowed on each helicopter. The stops are installed on the N1 control of each engine for maintenance engine topping checks. The stops provide an established fuel flow when topping. When not in use, the stops are stowed on the right side of the console aft of the pedals.

2-55. Emergency Power Panel. The emergency power panel is on the overhead switch panel. (See figure 2-8.) The panel is labeled EMERGENCY POWER. The panel consists of an emergency power indicator and a digital timer for each engine. (See figure 2-12.) The timer counts the minutes that emergency power is in use.

2-56. Emergency Power Caution Lights. Two press-to-test caution lights labeled EMERG PWR (figure 2-7) are installed: one light is on the copilots instrument panel outboard of the rotor tachometer and torquemeter. The other light is on the pilots panel inboard of the rotor tachometer and torquemeter. When on, the lights indicate ptit on one or both of the engines is in the emergency power range.

2-57. Oil Supply System.

The oil supply system is an integral part of the engine. The oil tank is part of the air inlet housing. The tank filler neck is on top of the housing. An oil level indicator is on the left side of the engine inlet housing. Refer to table 2-3 for the tank capacity. If the oil level decreases to about 2 quarts usable, the corresponding ENG OIL LOW caution light will come on.

2-58. Engine Oil Consumption. Operational usage of the engine should not be restricted because of oil consumption, unless the rate will curtail the mission.

2-59. Engine Start System.

The engine start system includes the hydraulic starters on each engine, the engine start valves and the solenoid-operated pilot valves on the utility system pressure control modules, the START switches and caution lights, the ignition LOCK switch, and the start fuel solenoids and ignition exciters on the engines.

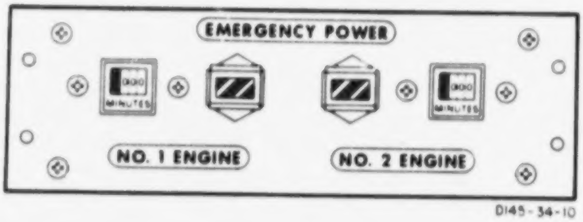


Figure 2-12. Emergency Power Panel

When the start switch is moved to MOTOR, the STARTER ON caution light (figure 2-13) comes on and the start valve opens. The start valve applies utility system pressure from the apu to the engine starter; rotating the engine starter and compressor. At 10 to 15 percent N1, the engine condition lever is moved to GROUND. The start switch is immediately moved to START, energizing the ignition exciter. Start fuel is sprayed into the combustor and combustion begins. Prior to ptit reaching 450°C, the START switch is manually released to MOTOR. At MOTOR, the start fuel valve is closed and the ignition exciter is deenergized. The engine then accelerates to a ground idle speed. At 50 percent N1, the START switch is manually moved to the locked OFF position. At OFF, the pilot valve closes, closing the start valve and deenergizing the STARTER ON caution light. A relay in each engine start circuit is energized when either START switch is at MOTOR or START. The relay, when energized, disables the start circuit of the opposite engine, preventing simultaneous dual engine starts. The start and ignition circuits receive power from No. 1 and No. 2 dc buses thru the START & TEMP and IGN circuit breakers on the power distribution panels.

2-60. Engine START Switches. Two engine start switches are on the START panel (figure 2-13) on the overhead switch panel. The switches are locked in OFF, detented in motor and spring-loaded from START to MOTOR. At START, the engine is rotated with start fuel and the ignition circuits are energized. At MOTOR, the engine is rotated by the starter, but ignition and start fuel circuits are deenergized. MOTOR is selected during starting, in case of engine fire, or to clear the combustion chamber after a false start.

2-61. STARTER ON Caution Lights. (See figure 2-13.) Two STARTER ON caution lights, one for each engine, are on the START panel. The lights will come on when the associated START switch is moved to MOTOR or START. The light alerts the pilots when the START switch is inadvertently left at MOTOR. The lights receive 28-volt dc from the No. 1 and No. 2 dc buses thru the START & TEMP circuit breaker on the power distribution panels.

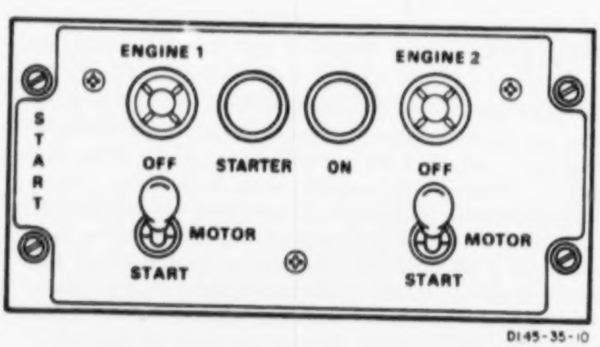


Figure 2-13. Engine Start Panel

2-62. Ignition Lock Switch.

An ignition system lock switch (figure 2-5) is installed on the right side of the console forward of the thrust control. The key-operated switch prevents unauthorized use of the helicopter. When the switch is off, the circuits to the ignition exciters and the start fuel solenoids of both engines are open. Therefore, the engines cannot be started. Be sure both START switches are OFF before turning the ignition lock switch ON or OFF.

2-63. Engine Instruments and Caution Lights.

The engine instruments are the gas producer tachometer, the dual torquemeter, power turbine inlet temperature, fuel flow, oil pressure and temperature. The caution lights are the NO. 1 and NO. 2 EMERG PWR, NO. 1 and NO. 2 ENGINE OIL LOW, and NO. 1 and NO. 2 ENG CHIP DET.

2-64. Gas Producer Tachometer.

Two gas producer tachometers (figure 2-7), one for each engine, are on the center section of the instrument panel, above the ptit indicators. Each tachometer displays gas producer turbine speed in percent of N1. The outer scale of the tachometer is calibrated from 0 to 100 in increments of two. The smaller, vernier scale calibrated 0 to 10, in increments of one. Each tachometer operates from power supplied by a gas producer tachometer generator on the accessory gear box section of each engine.

2-65. Torquemeter.

One torquemeter is on the pilot's instrument panel and the other on the copilot's instrument panel (figure 2-7). Each torquemeter has two pointers, one for each engine, marked 1 and 2. Each torquemeter has a range of 0 to 150 percent of maximum torque. The power output shaft of the engine rotating within the electric torquemeter head assembly acts as the primary winding of a transformer. A power supply unit (inverter) provides the reference signal for the winding of the torquemeter head assembly. The current produced by the transformer is proportional to the torque developed by the engine. A torquemeter junction box assembly on the air inlet housing of the engine converts the output of the transformer to direct current. This current provides the electrical signal for operation of the torquemeter. Power to operate the torquemeters is provided by No. 1 and No. 2 115-volt ac buses thru the ENGINE NO. 1 and NO. 2 TORQUE AC circuit breakers on the power distribution panels. Power for the power supply unit is provided by the No. 1 and No. 2 28-volt dc buses thru the ENGINE NO. 1 and NO. 2 TORQUE DC circuit breakers on the power distribution panels.

2-66. Power Turbine Inlet Temperature Indicators.

Two power turbine inlet temperature (ptit) indicators, one for each engine, are on the center section of the instrument panel. Each indicator is calibrated 0° to 1,200°C. The temperatures registered on the power turbine inlet temperature indicator are transmitted by chromel-alumel thermocouples. The thermocouples sense gas temperature at the power turbine inlet and transmit an average gas temperature reading to the ptit indicator in the cockpit. When power turbine inlet temperature increases to the emergency power range, the EMERG PWR caution light will come on. If power turbine inlet temperature is maintained in the emergency power range for more than 5-seconds, the indicator will apply 28-volt dc from the ENGINE START & TEMP circuit breaker to the applicable emergency power panel. With 28-volt dc applied to the panel, the emergency power timer will start, and an indicator flag will trip.

2-67. *Engine Oil Temperature Indicator.*

Two engine oil temperature indicators (figure 2-7) are on the center section of the instrument panel. Each engine oil temperature indicator is calibrated from −70° to +150°C. A temperature probe within the lubrication lines of the engine, before the fuel-oil cooler, is the point at which the temperature is sensed. Power to operate the resistance-type oil temperature circuit is supplied by No. 1 and No. 2 28-volt dc buses thru the ENGINE OIL TEMP circuit breakers on the power distribution panels.

2-68. *Engine Oil Pressure Indicator.*

An engine oil pressure indicator (figure 2-7) on the center instrument panel is provided for each engine. Each indicator relates pressure sensed at No. 2 bearing by an oil pressure transmitter mounted near the engine. Each engine oil pressure indicator displays a pressure range from 0 to 200 psi. Power to operate the engine oil pressure circuit is supplied by the 26-volt ac instrument buses thru the ENGINE OIL PRESS circuit breakers on both power distribution panels.

2-69. *Engine Chip Detector Caution Light.*

Two ENG CHIP DET caution lights are on the master caution panel (fig. 2-46). The caution lights are electrically connected to a chip detector in each engine and engine transmission. If a detector is bridged by metal particles which may indicate impending engine or engine transmission failure, the corresponding ENG CHIP DET caution light will come on. Also, the associated ENGINE CHIP DETECTOR or TRANSMISSION CHIP DETECTOR magnetic indicator on the maintenance panel (fig. 2-27) will trip.

2-70. *Engine Oil Level Caution Light.*

Two engine oil level caution lights, marked NO. 1 ENG OIL LOW and NO. 2 ENG OIL LOW, are on the master caution panel (figure 2-46). When a caution light comes on, there are about 2 quarts of usable oil remaining in the respective engine oil tank. Each low oil level caution light is activated by a microswitch inside the oil quantity indicator. Power to operate the oil level caution lights is supplied by the 28-volt dc essential bus thru the CAUTION PNL circuit breaker on No. 1 power distribution panel.

2-71. *Engine Chip Detectors.*

Two caution lights, marked NO. 1 ENG CHIP DET and NO. 2 ENG CHIP DET, are on the master caution panel. The engine accessory section oil sump chip detector is connected to the corresponding ENG CHIP DET caution light on the master caution panel and to the ENGINE CHIP DETECTOR indicators on the maintenance panel. (See fig. 2-14.)

2-72. *Engine Interstage Air Bleed.*

To aid compressor rotor acceleration and prevent compressor stall, an interstage air bleed system is provided on each engine. A series of vent holes thru the compressor housing at the sixth stage vane area allows pressurized air to bleed from the compressor area. This enables the compressor rotor to quickly attain a preselected rpm. The pneumatic interstage air bleed actuator controls operation of the air bleed by tightening or loosening a metal band over the vent holes. The interstage air bleed system operates automatically when the engine condition levers or the engine beep trim switches are used to govern rpm. Should the bleed band malfunction and remain open, there would be a noticeable loss in power.

NOTE

> Bleed band oscillations at low torque settings (approximately 30% torque per engine), indicated by fluctuating rpm and torque, can occur and are not cause for engine rejection.

2-73. *Engine Drain Valves.*

Pressure-operated engine drain valves are in the bottom of each engine combustion housing. The valves automatically drain unburned fuel from the combustion chamber following a false start or whenever the engine is shut down. One valve is at the forward end of the combustion chamber and the other is at the aft end to ensure complete drainage.

SECTION IV FUEL SYSTEM

2-74. Fuel Supply System.

The fuel supply system furnishes fuel to the two engines, the heater, and the apu. Two separate systems, connected by crossfeed and a pressure refueling lines are installed. Provisions are available within the cargo compartment for connecting internal ferry fuel tanks to the two fuel systems. Each fuel system consists of three fuel tanks contained in a pod on each side of the fuselage. The tanks are identified as forward auxiliary, main, and aft auxiliary tanks. During normal operation, with all booster pumps operating, fuel is pumped from the auxiliary tanks into the main tanks, then from the main tanks to the engine. A simplified fuel flow diagram is engraved on the fuel control panel. When the fuel is consumed in an auxiliary tank, the fuel pump is automatically shut off and a check valve closes to prevent fuel from being pumped back into that tank. Should a fuel pump fail in an auxiliary tank, the fuel in that tank is not usable. However, should both booster pumps fail in a main tank, fuel will be drawn from the main tank as long as the helicopter is below 6,000 feet pressure altitude. Fuel is delivered to the apu from the left main tank and to the heater from the right main tank. Fuel system switches and the auxiliary tank low pressure caution lights are on the fuel control panel (figure 2-14) of the overhead switch panel, the fuel line pressure caution lights are on the master caution panel (figure 2-6), and the fuel flow meter is on the center instrument panel. The single point pressure refueling panel and nozzle adapter are on the right side above the forward landing gear. Refer to Section XV for fuel tank capacities, fuel grades, and fuel system servicing procedures.

2-75. Fuel Tanks.

The fuel tanks are crashworthy, self-sealing tanks with breakaway fittings. The main fuel lines are constructed of self-sealing material. Penetration of the tank wall or a fuel line by a projectile exposes the sealant to the fuel, activates the sealant, and closes the hole. Breakaway self-sealing fittings are installed where the main fuel lines connect to the fuel tank and adjacent structure. Under high impact loads, the fittings shear or break at predetermined locations, seal themselves, retain the fuel, keeping fuel loss and post-crash fire hazard to a minimum. Electrical cables having lanyard-release type connectors, are installed where the cables are attached to adjacent structure. The connectors automatically release if the fuel tank breaks away from the pod.

Each main tank contains two fuel booster pumps, three fuel quantity probes, a jet pump for evacuating the pressure refueling system, a dual pressure refueling shutoff valve, a dual fuel level control valve, and a gravity filler port.

Each auxiliary tank contains a fuel pump with automatic shutoff feature, a quantity probe, a dual pressure refueling shutoff valve, and a dual fuel level control valve.

Also, a rollover vent system is installed in each tank. This system prevents fuel spillage from the vents should the helicopter roll over following a crash landing. The vent system within the tanks have a condensate drain at the aft end, however, aircraft maneuvering should never force fuel into the vents. Sump drains are also installed on the bottom forward end of each tank.

2-76. Controls and Indicators.

The fuel controls are the booster pump and crossfeed fuel valve switches and the engine fuel and manual defueling valves. Indicators include the crossfeed fuel and engine fuel valve indicating lights, the fuel quantity indicator and caution lights, fuel flow indicator, and the auxiliary tank and fuel line pressure caution lights. Refer to para 2-89 for a description of the pressure refueling system controls and indicators.

2-77. Fuel Pump Switches. Eight 2-position fuel booster pump switches are on the fuel control panel (figure 2-14) on the overhead switch panel. Each switch controls a single-speed electrically driven fuel booster pump. Marked next to each switch is the name of the pump which it operates. Each switch has two positions: ON and OFF. When one of these switches is at ON, power from the No. 1 or No. 2 28-volt dc bus closes the respective pump relay connecting power from the No. 1 or No. 2 115/200-volt 3-phase ac primary bus to energize the pump. Four circuit breakers for these relay circuits are on the dc section of each power distribution panel. They are marked LH and RH FUEL PUMP CONT — AUX AFT, MAIN AFT, MAIN FWD, and AUX FWD. There are four 3-phase circuit breakers for the pumps circuits on the ac section of each power distribution panel. They are marked LH and RH FUEL PUMPS — MAIN FWD, MAIN AFT, AUX FWD, and AUX AFT.

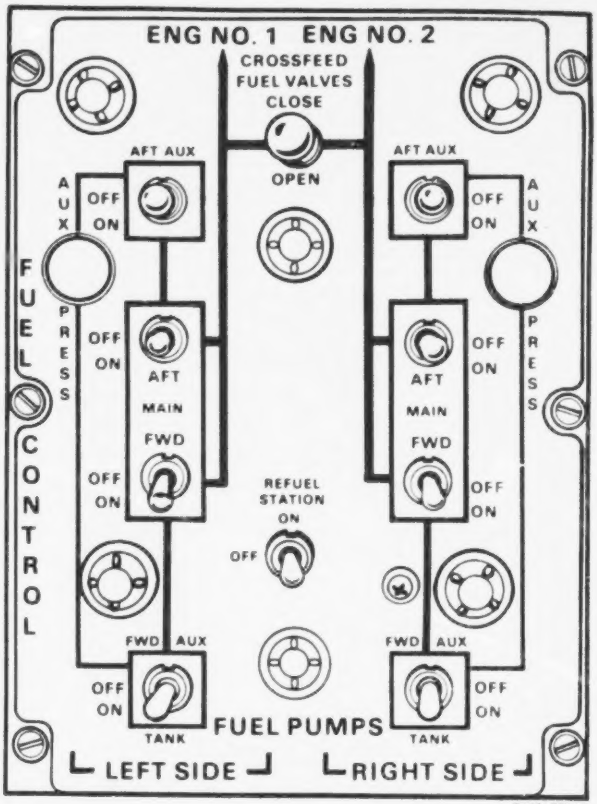


Figure 2-14. Fuel Control Panel

2-78. Crossfeed Fuel Valves Switch. A two-position crossfeed fuel valves switch is on the fuel control panel (figure 2-14). The switch electrically operates two fuel valves in the crossfeed line. The switch has two positions: OPEN and CLOSE. When the switch is at OPEN, power from the 28-volt No. 1 dc bus thru the X-FEED CONT circuit breaker on No. 1 power distribution panel, opens the fuel valves. When the switch is at CLOSE, electrical power closes the valves (figure 2-15). A lever is on each valve for manually operating the valve during electrical failures. The crossfeed fuel valves are protected against short circuit closings and each valve has an indicating light.

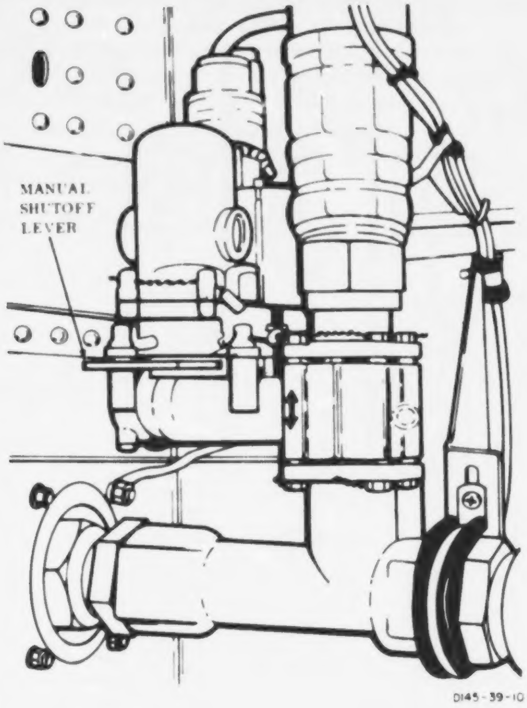


Figure 2-15. Crossfeed Fuel Valve, Sta 504

2-79. Crossfeed Fuel Valve Indicating Lights. Two PRESS-TO-TEST crossfeed fuel valve indicating lights (figure 2-16), each next to a crossfeed fuel valve, are installed to indicate the operating condition of the individual crossfeed valve and associated circuitry. The light will come on under any of the following conditions:

a. The light will come on each time the crossfeed valves switch is moved from CLOSE to OPEN or OPEN to CLOSE. After this operation, the light should go out, indicating the crossfeed valve is synchronized with the switch position.

b. The light will be on continuously if a short circuit occurs, causing a signal to be applied opposite to the valve position. However, the valve will remain at the position last selected by the crossfeed valves switch.

c. The light will be on continuously should the crossfeed valve protection relay fail. Should the light come on, the crossfeed valve will remain at the last selected position and the valve can be operated electrically or manually, as required. Power to operate the crossfeed fuel valve indicating lights is supplied by the No. 1 28-volt dc bus thru the X-FEED CONT circuit breaker on the No. 1 power distribution panel.

2-80. Engine Fuel Valves. One engine fuel valve (figure 2-17) is in the fuel supply line to each engine. Each valve can be operated electrically or manually. The valve is electrically operated by the fire control handles (para 2-9) and manually by a lever on the valve. The valves are also equipped to provide protection against short-circuit closings and are equipped with an indicating light.

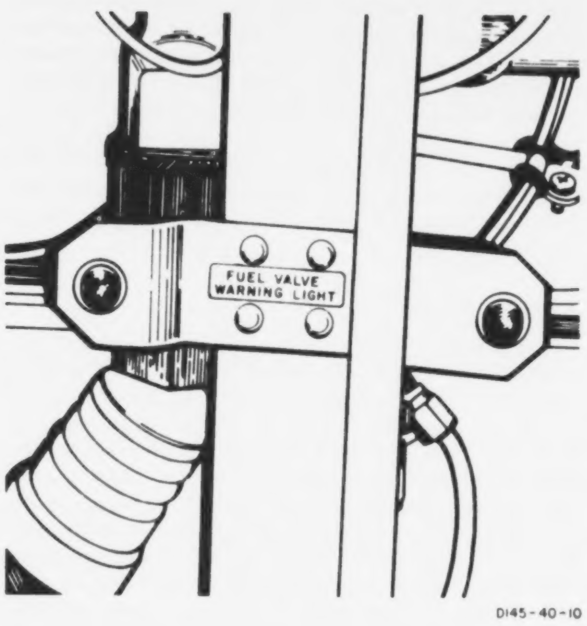


Figure 2-16. Fuel Valve Indicating Light, Sta 500

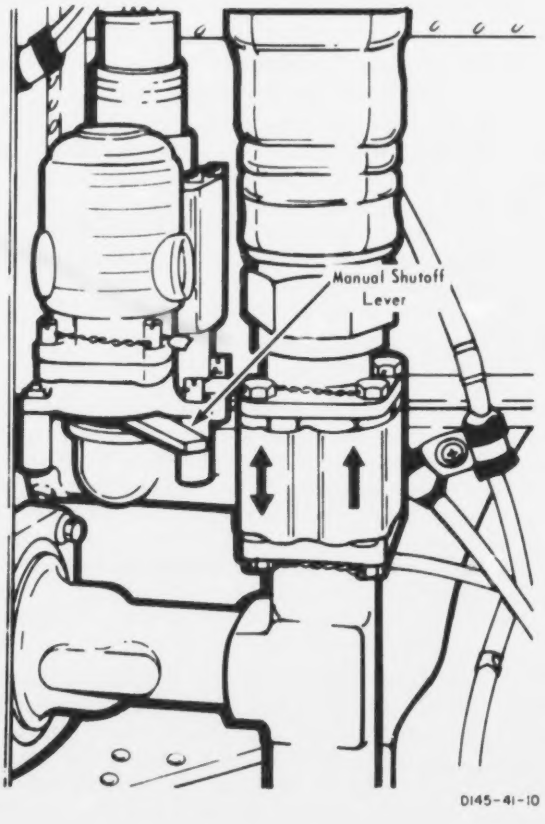


Figure 2-17. Engine Fuel Valves, Sta 498

2-81. *Engine Fuel Valve Indicating Lights*. Two PRESS-TO-TEST engine fuel valve indicating lights (figure 2-17), one next to each engine fuel valve, indicate the operating condition of the respective fuel valve and associated circuitry. The light will come on under the same conditions described in para 2-78. Power to operate the engine fuel valve indicating lights is supplied by the 28-volt dc buses thru ENGINE FUEL SHUTOFF NO. 1 and NO. 2 circuit breakers on the power distribution panels.

2-82. *Manual Defueling Valve*. A manual defueling valve (figure 2-18) is in the aft cargo compartment next to No. 2 engine fuel valve. The defueling valve has a selector which is rotated in the appropriate direction to open or close the valve. Instructions on how to open or close the valve are stenciled on the fuselage skin immediately behind the valve. The valve should be used only by maintenance personnel to defuel the helicopter or adjust fuel load.

2-83. *Fuel Quantity Indicator*. An indicator calibrated to measure fuel quantity in pounds (figure 2-19) is on the center section of the instrument panel. The indicator provides two types of display. One display is in digital form and the other is a pointer. The digital readout continuously indicates the total amount of fuel remaining in all the fuel tanks. The pointer remains hidden until one of the tank positions on the fuel quantity selector switch is selected. Then, the pointer will indicate fuel remaining in that tank. The fuel quantity indicator is electrically connected to 10 capacitance-type measuring units in the tanks. The 115-volt ac No. 1 bus supplies electrical power for the indicator and switch thru the FUEL QTY circuit breaker on the No. 1 power distribution panel.

2-84. *Fuel Quantity Selector Switch*. A fuel quantity selector switch (figure 2-19) is on the center section of the instrument panel below the fuel quantity indicator. The switch has seven positions: TOTAL, left and right FWD, MAIN, and AFT. Selecting any position other than TOTAL causes the indicator pointer to display the fuel remaining in that tank. The digital readout is not affected during individual tank readings.

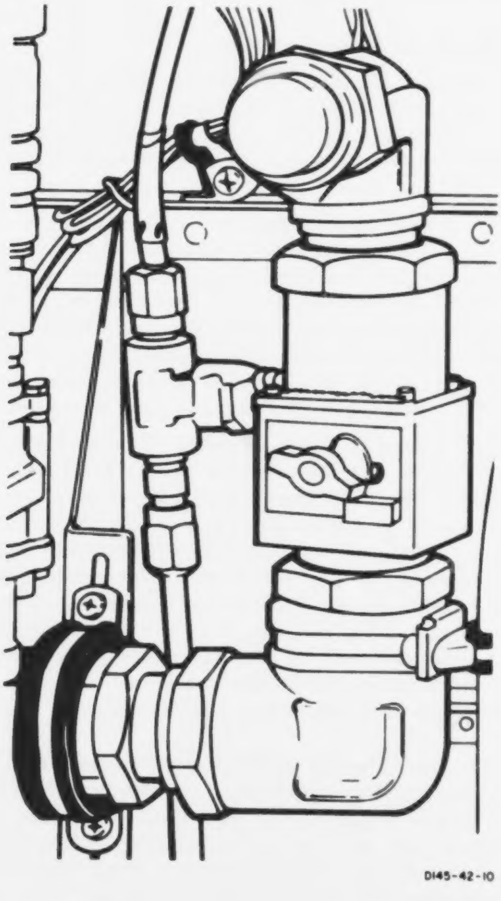


Figure 2-18. Manual Defueling Valve, Sta 507

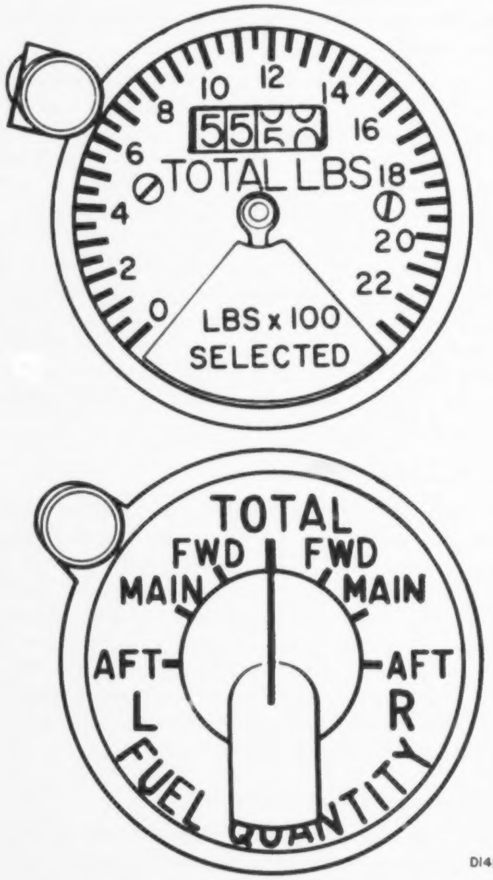


Figure 2-19. Fuel Quantity Selector Switch and Indicator

2-85. Fuel Quantity Caution Lights. Two amber fuel quantity caution lights, one for each main tank, are on the master caution panel (figure 2-46) of the console. Each light is electrically connected to a thermistor sensor on a measuring unit in the respective main tank. These lights are marked L FUEL LOW and R FUEL LOW. When there is 20 percent of fuel remaining in the main tank, the caution light for that main tank comes on. (Twenty percent of fuel is equal to 320 to 420 pounds.) Electric power for these lights is supplied by the 28-volt dc essential bus thru the CAUTION PNL circuit breaker on the No. 1 power distribution panel.

2-86. Fuel Pressure Caution Lights. Two caution lights marked L FUEL PRESS and R FUEL PRESS are on the master caution panel. Each caution light is electrically connected to a fuel pressure switch between the main tank and the engine fuel valves. When one of these lights comes on, it indicates that fuel pressure in the respective fuel line is below 10 psi. Power to operate the caution lights is provided by the 28-volt dc essential bus thru the CAUTION PNL circuit breaker on No. 1 power distribution panel. Fuel pressure is measured after the fuel booster pumps and not at the engine driven pump. When a fuel pressure caution light comes on, it does not represent a possible engine flameout, unless flight is being conducted above 6,000 feet pressure altitude.

2-87. Auxiliary Tank Pressure Caution Lights. Two PRESS-TO-TEST AUX PRESS caution lights are on the fuel control panel (figure 2-14) of the overhead switch panel. Each light is electrically connected to the forward and aft auxiliary tank pressure switches. When this caution light comes on, it indicates that the fuel pressure in either the forward or aft auxiliary fuel line has dropped below 9 to 11 psi. The auxiliary tank fuel booster pump switches must be at ON to provide electrical power from the 28-volt dc No. 1 bus to power the caution light. Power to operate the caution light is received from the LH or RH FUEL PUMPS AUX FWD & AUX AFT circuit breakers on No. 1 and No. 2 power distribution panels. Light intensity can be adjusted by turning the light housing.

2-88. Fuel Flow Indicators.

A dual fuel-flow indicator, on the center instrument panel (figure 2-7), indicates fuel flow to each engine in pounds per hour. The indicator dial is graduated from 0 to 3000 pounds per hour in 100 pound increments. The signal to drive the indicator is derived from a fuel flow transmitter in the fuel line of each engine at the quick disconnect shelf. Power to operate the No. 1 indicator is from the No. 1 ac bus thru the FUEL FLOW circuit breaker. Power to operate the No. 2 indicator is from the No. 2 ac bus through the FUEL FLOW circuit breaker.

2-89. Pressure Refueling System.

The pressure refueling system permits rapid refueling of all fuel tanks simultaneously or selective refueling of any tank or combination of tanks. Maximum fueling rate is 300 gallons/per minute. The system control panel and refueling nozzle receptacle are on the right side of the helicopter above the forward right landing gear. In addition to the control panel and refueling receptacle, the system consists of a dual fuel level control valve and a dual fuel shutoff valve in each tank. A jet pump is also installed in each main tank. A pressure refueling manifold connects all tanks to the pressure refueling receptacle. The dual fuel level control valves control the operation of the dual fuel shutoff valves. When fuel in a tank rises to the full level during pressure refueling, the floats in the control valve close and apply a signal to the shutoff valve, closing it. The floats can also be closed electrically to stop fuel flow into a tank at some intermediate level. The floats are controlled by the shutoff valve test switches on the refueling control panel. The pressure refueling manifold does not include projectile resistant features because the fuel is evacuated prior to flight. The jet pump in each main tank is installed to evacuate the refueling manifold and discharge the displaced fuel into the main tank. The jet pump is activated when the forward boost pump in each main tank is first turned on following pressure refueling. Electrical power to operate the pressure refueling system is derived from the 28-volt battery bus through the REFUEL circuit breaker on the No. 1 pdp. Electrical power is applied to the system only when the REFUEL STATION switch on the cockpit FUEL CONTROL panel is at ON.

2-90. Controls and Indicators.

Except for the REFUEL STATION switch on the cockpit FUEL CONTROL panel, all pressure refueling system controls and indicators are on the pressure refueling station panel (figure 2-20) under the access panel at the forward right landing gear.

2-91. Power Control Switch. The power control switch at PWR ON applies electrical power to the pressure refueling system and to the refueling station quantity indicator provided the REFUEL STATION switch on the cockpit fuel control panel is at ON. When set to PWR ON, the PWR ON light will come on, the fuel quantity indicator will register the quantity of fuel in the tanks, and the REFUEL VALVE POSN lights will come on momentarily.

2-92. Refueling Station Switch. The REFUEL STATION switch on the overhead FUEL CONTROL panel (figure 2-14) at ON applies electrical power from the battery bus to the PWR ON switch on the refueling station panel. Setting the switch to OFF after pressure refueling, closes the refuel valves and discontinues electrical power to the refueling panel. When pressure refueling, be sure the switch is at ON at all times. If the switch is at OFF, the aft auxiliary tanks will not fill, the remaining four tanks will fill to maximum, the fueling station quantity indicator is inoperative, and there is no precheck capability.

2-93. Fuel Quantity Indicator and Selector Switch. The pressure refueling station fuel quantity indicator and selector switch (figure 2-20) are identical to those in the cockpit. The indicator at the refueling station indicates fuel quantity only when the REFUEL STATION switch on the cockpit FUEL CONTROL panel (figure 2-15) is at ON and the PWR switch on the refueling station panel (figure 2-20) is at PWR ON. Electrical power to drive the indicator is 115 volt, 400 Hz ac from a solid-state inverter in the cabin at sta 220. The inverter, in turn, is powered by 28-volts dc from the battery bus through the REFUEL circuit breaker on the No. 1 pdp. With the selector switch at TOTAL, the quantity of fuel in all tanks will be displayed on the totalizer and the indicator pointer is hidden behind the mask. When the selector is rotated from TOTAL to a specific tank, the pointer will appear from behind the mask and indicate the fuel quantity in that tank. The totalizer will continue to display total fuel quantity.

2-94. *Fuel Cell Shutoff Valve Test Switches*. Seven three-position fuel cell shutoff valve test switches are on the refueling control panel (figure 2-20). The switches are used to test the automatic shutoff features in each tank and to stop refueling when the desired fuel level is attained in each or all tanks. Six of the seven switches are connected to fuel level control valves in a specific tank. The seventh switch, labeled ALL TEST, is electrically connected to the fuel level control valves in all six tanks. Setting any of the six switches to PRI OFF or SEC OFF raises the corresponding primary, or secondary float in the fuel level control valve, simulating a high fuel level, and causing the fuel shutoff valve in that tank to close. Setting the ALL TEST switch to PRI OFF or SEC OFF, raises the corresponding float in all six tanks, shutting off fuel flow into all tanks simultaneously.

2-95. *Refuel Valve Position Indicating Lights*. The two amber press-to-test REFUEL VALVE POSN lights (figure 2-20) indicate the status of the two refueling valves in the pressure refueling system. The valves are normally closed and prevent fuel feedback into the aft auxiliary tanks when the aft tank pumps are operating. While pressure refueling, the valves are open and allow fuel flow from the refueling system into the aft tank. The valves are controlled by the refueling station PWR ON switch. When the switch is ON, the valves are open; when OFF, the valves are closed. The lights will come on momentarily, when the switch is set to PWR ON, indicating valve transition from closed to open. Conversely, the lights will come on momentarily when the switch is set to OFF; indicating valve transition from open to close. A continuously lit light with the switch at OFF, indicates the associated valve is open and the fuel in that tank will not be available.

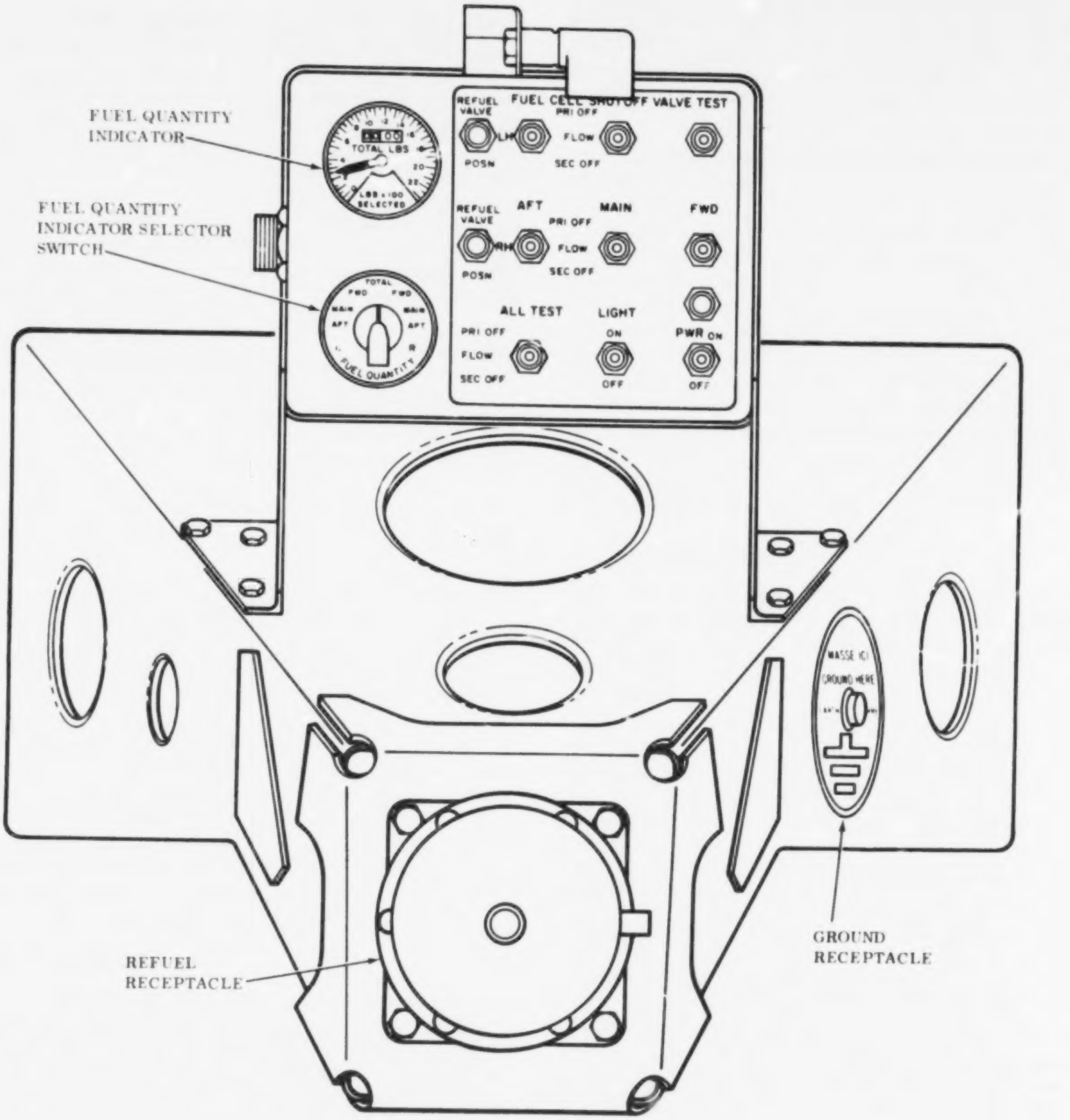

FUEL QUANTITY INDICATOR
FUEL QUANTITY INDICATOR SELECTOR SWITCH
TOTAL LBS
LBS x 100 SELECTED
TOTAL
FWD
MAIN
AFT
L
R
FUEL QUANTITY
REFUEL VALVE
LH
RH
POSN
FUEL CELL SHUTOFF VALVE TEST
PRI OFF
FLOW
SEC OFF
AFT
MAIN
FWD
ALL TEST
LIGHT
ON
OFF
PWR
MASSE ICI
GROUND HERE
REFUEL RECEPTACLE
GROUND RECEPTACLE
D145-167-10

Figure 2-20. Pressure Refuelling Station

SECTION V FLIGHT CONTROLS

2-96. Flight Control System.

The helicopter is controlled by changing the pitch of the blades either collectively or cyclically. Pitch changes are made by the pilot's movement of the flight controls which include a thrust control, a cyclic control stick, and directional pedals. The pilot's controls are interconnected with the copilot's controls.

CAUTION

> The pilot or copilot must man the flight controls at all times when the rotors are turning.

Flight control movements are transmitted thru a system of bellcranks, push-pull tubes, and actuators to a mixing unit just aft of the cockpit, next to the forward transmission. The control movements are mixed to give the correct lateral cyclic and collective pitch motions to the rotors thru dual hydraulic actuators. These boost actuators are under each swashplate. Each set of dual actuators is normally powered by both flight control hydraulic systems. The helicopter is vertically controlled with the thrust control thru application of equal pitch to all blades. Directional control is obtained with the directional pedals by imparting equal but opposite lateral cyclic pitch to the blades. Lateral control is obtained by application of equal lateral cyclic pitch to the blades with the cyclic control stick. The helicopter is controlled longitudinally with the cyclic stick thru application of differential collective pitch. For a fwd stick motion, the pitch of the fwd rotor blades is decreased collectively while the pitch of the aft rotor blades is increased collectively. The opposite action occurs with aft movement of the cyclic stick. In addition, the helicopter has an advanced flight control system (AFCS). AFCS provides the following features:

a. Rate damping in all axes and sideslip stability.
b. Pitch and roll attitude hold and heading hold.
c. Airspeed hold.
d. Improved control response in pitch, roll, and yaw.
e. Barometric and radar altitude hold.
f. Automatic coupled turns.
g. Longitudinal cyclic trim scheduling.

2-97. Thrust Control.

Either thrust control (fig. 2-21) is used to apply equal pitch simultaneously to both rotors, thus controlling ascent and descent of the helicopter. Raising thrust control increases pitch. Lowering thrust control decreases pitch. An integrated lower control actuator (ilca) is installed between the thrust control and the mixing unit. This actuator assists the pilot in moving the thrust control. A cockpit control driver actuator (ccda) is also installed in the thrust control system. This actuator responds to signals from the AFCS and increases or decreases collective pitch on the blades to maintain a constant altitude. In addition, a balance spring is installed that counteracts the downward imbalance of the thrust control. A detent capsule establishes a ground operation detent to reduce droop stop pounding. A viscous damper in the thrust control system improves control feel. The thrust control is also electrically linked to the power turbine actuator thru the droop eliminator system. An upward movement of the thrust control electrically increases the power turbine governor speed setting to compensate for inherent engine droop and maintain engine speed as rotor loads are increased. A downward movement of the thrust control electrically decreases the power turbine governor speed setting. Mounted on each thrust control is an auxiliary switch bracket containing a searchlight control switch, a searchlight filament switch, and the two engine beep trim switches.

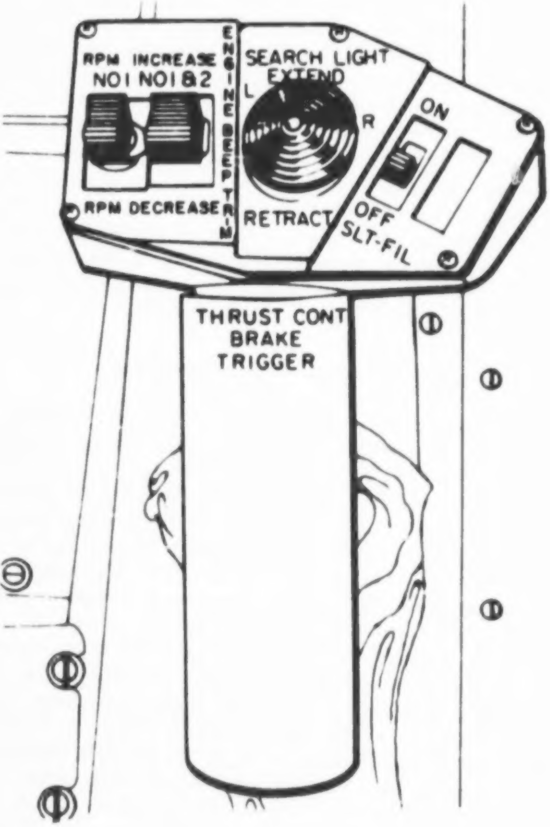


Figure 2-21. Thrust Control

2-98. Thrust Control Brake Switches.

A trigger switch under each thrust control grip (fig. 2-21) controls the magnetic brake of the collective cockpit control driver actuator (ccda) in the flight control closet. Pressing the switch applies electrical power to release the magnetic brake in the actuator. The thrust control can then be freely moved. With barometric or radar altitude hold selected, squeezing the trigger disables altitude hold. The AFCS will hold the altitude at the time the trigger is released. When the switch is released, the magnetic brake is applied, holding the thrust control in position. Current is supplied to the thrust control magnetic brake from the essential dc bus thru the THRUST BRAKE circuit breaker on the No. 2 power distribution panel. Should the magnetic brake malfunction, the magnetic brake will slip at a predetermined force between 10 and 20 pounds.

2-99. Cyclic Control Sticks.

Each cyclic control stick (fig. 2-22) is used for lateral and longitudinal control of the helicopter. Moving the stick to the right tilts both rotor disks equally to the right and causes the helicopter to roll to the right in flight. Moving the stick to the left causes the opposite movement. Moving the stick forward simultaneously decreases pitch of the forward rotor blades and increases pitch of the aft rotor blades, causing a nose-down helicopter attitude in flight. Moving the stick aft causes the opposite movement resulting in a nose-up attitude. Two integrated lower control actuators (ilcas), one for lateral control and one for longitudinal control, are installed to assist the pilot in moving the stick. In addition to these actuators, viscous dampers are installed. One damper is for longitudinal control and one for lateral control to improve control feel. Located on the pilot's and the copilot's cyclic control stick grips are a centering device release switch, an AFCS trim switch, a cargo hook release switch, interphone-transmitter trigger switch, and a flare dispenser control switch.

2-100. Centering Device Release Switches.

The centering device release switches (fig. 2-22), marked CENTERING DEVICE RELEASE, are on each cyclic control stick. The button switch is used to simultaneously release the force feel trim magnetic brakes for the lateral, the longitudinal, and the directional flight controls and disengages bank angle, heading hold and heading select functions when AFCS is operating. A centering spring and a magnetic brake for each control provide a sense of force feel to hold the control in a trim position. However, the pilot can override the force manually while maneuvering the helicopter. When the switch is pressed, electrical power is applied to release the magnetic brakes; each centering spring assumes a new trim position where the control forces are nulled. Releasing the switch removes electrical power and applies the magnetic brakes; the centering springs are retained in their new positions. Power to operate the magnetic brakes is supplied by the 28-volt switched battery bus thru a circuit breaker labeled CONT CTR, on the No. 1 power distribution panel. The magnetic brake for longitudinal control is in the longitudinal cockpit control driver actuator.

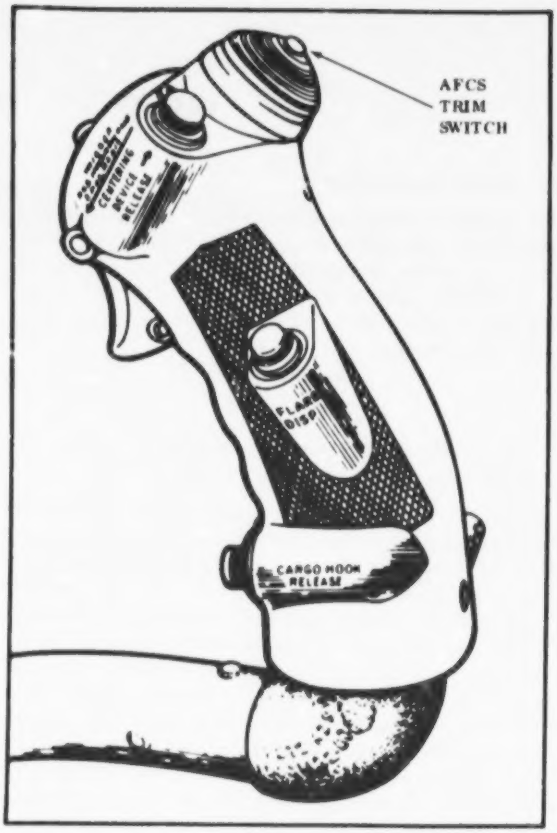


Figure 2-22. Cyclic Control Stick Grip

2-101. AFCS Trim Switches. The AFCS trim switches (fig. 2-22) are on each cyclic control stick. The switches are used to make small changes in pitch (airspeed) and roll attitude while the AFCS is operating. The switches are spring-loaded to center off position. Moving the switch forward or aft from center off position commands an increase (forward) or decrease (aft) in airspeed by driving a trim motor in the longitudinal ccda. Moving the switch left or right commands the roll ilca to bank the helicopter in the selected direction without moving the stick. Power to drive the pitch trim motor is from the 115-volt No. 1 ac bus thru the COLL DRIVER ACT circuit breaker on the No. 1 power distribution panel.

2-102. Directional Pedals.

The directional pedals (7 and 22, fig. 2-5) are used for directional control of the helicopter during flight and while taxiing with the forward gear off the ground. When the right pedal is displaced forward, the forward rotor disk tilts to the right and the aft rotor disk tilts to the left. The opposite action occurs when the left pedal is displaced forward. An integrated lower control actuator is installed to assist the pilot in moving the pedals. The pedals are adjusted individually fore and aft by depressing a lever mounted on the pedal support and moving the pedal to a new position before repositioning the lever. Insure that both pedals are adjusted equally (left and right pedals in same respective hole position) and pedal adjustment lockpins are engaged. A balance spring is installed to stop pedal creep. A viscous damper is installed to reduce control sensitivity.

2-103. Advanced Flight Control System (AFCS)

a. The Advanced Flight Control System (AFCS) stabilizes the helicopter about all axes and enhances control response. It automatically maintains desired airspeed, altitude, bank angle and heading. An automatic turns feature, coupled to the pilots or copilots horizontal situation indicator is also included in the AFCS. Two complete systems are installed. With both systems on, each system operates at half-gain. If one system fails, the remaining system operates at three quarter gain to compensate. The switchover produces no significant change in control feel or response. Built In Test Equipment (BITE) is installed in each AFCS computer. This equipment is intended for ground troubleshooting purposes only. An interlock circuit through the engine condition control box prevents BITE use while the engines are running. The HDG ENGAGED, BARO ALT and RAD ALT ENGAGED lights receive power through the 5 amp dc circuit breaker marked CAUTION PANEL on the NO. 1 pdp. The NO. 1 AFCS receives ac and dc power from the NO. 1 ac and dc buses respectively through two circuit breakers marked AFCS NO. 1 on the NO. 1 pdp. The NO. 2 AFCS receives ac and dc power from the NO. 2 ac and dc buses respectively through two circuit breakers marked AFCS NO. 2 on the NO. 2 pdp.

b. The AFCS consists of the following components:

(1) A cockpit control panel.

(2) Two AFCS computers in the electronics compartment.

(3) Three integrated lower control actuators (ilca) in the flight controls closet.

(4) A differential airspeed hold (dash) actuator in the flight controls closet.

(5) Two longitudinal cyclic trim actuators are installed, one in the forward upper controls, the other in the aft upper controls.

(6) Roll and yaw magnetic brakes, a longitudinal cockpit control driver actuator, and a collective cockpit control driver actuator, all in the flight controls closet.

(7) Three control position transducers.

c. Attitude changes sensed by the attitude gyros, a yaw rate gyro in each AFCS computer and the directional gyro are processed by the AFCS computers and applied to the ilcas. The ilcas extend or retract and move the upper flight controls. This control input is not apparent to the pilot because AFCS control inputs do not move the cockpit controls. The pitch, roll, and yaw axis all operate in fundamentally the same manner. Should a hardover occur, the pilot can easily override AFCS.

d. Pitch attitude stability, airspeed hold and a positive stick gradient from hover to V-max are provided thru the dash actuator. The dash actuator extends or retracts to maintain airspeed for a given stick position.

2-104. *Bank Angle Hold.*

Bank angle trim without cyclic stick movement is provided through left or right positioning of the cyclic stick AFCS trim switch. Bank angle hold is disengaged anytime a CENTERING DEVICE RELEASE button is pressed, a cyclic stick is moved laterally, or the HDG button is ENGAGED. Bank angle hold cannot be used again until roll rate is less than 1.5° per second.

2-105. *Heading Hold*

The directional gyro provides an input to each AFCS which signals the yaw ilcas to maintain heading within 2 degrees. Heading hold is disengaged if the swivel switch is set to STEER or UNLOCK, a CENTERING DEVICE RELEASE button is pressed, or the pedals are moved. Also, heading hold will be disengaged at airspeed above 40 knots anytime lateral trim is used, the stick is moved laterally, or HDG is ENGAGED. Heading hold will not resume until yaw rate is less than 1.5 degrees per second and at airspeed above 40 knots, bank angle is less than 1.5 degrees.

2-106. *Airspeed Hold*

The airspeed hold feature provides a constant airspeed and pitch attitude relative to stick position at airspeeds above 40 knots. Airspeed and pitch can be set with the AFCS trim switch on the cyclic stick or by displacing the cyclic stick until the desired airspeed is achieved then pressing the CENTERING DEVICE RELEASE. A circuit in the dash prevents large pitching transients when AFCS is turned off at one airspeed and turned back on at another airspeed. This circuit automatically slows dash actuator response and illuminates both AFCS caution lights until actuator extension corresponds to the command signal. The circuit is activated when the AFCS switch is turned from off to an on position. Abrupt or large changes in airspeed during flight with the AFCS ON will not activate the circuit.

2-107. *Altitude Hold*

Two methods of altitude hold can be selected. Radar altitude hold and barometric altitude hold. For hovering within 1,500 feet of the ground, radar altitude hold is used. For forward flight, barometric altitude hold is used.

a. Radar Altitude Hold. Radar altitude hold will hold a more precise altitude in hover than barometric altitude hold. An error signal caused by radar altitude deviations is derived from the pilot's radar altimeter receiver-transmitter, processed by the No. 1 AFCS computer and applied to the collective cockpit control driver actuator (ccda). The ccda responds to the error signal by driving the thrust control in the direction necessary to null the error signal.

b. Barometric Altitude Hold. Barometric altitude hold uses error signals produced by the No. 1 AFCS computer. The error signal is produced in response to static pressure changes and is proportional to altitude changes. The signal is processed by the AFCS and applied to the collective cockpit control driver actuator (ccda). The ccda drives the thrust controls in the direction necessary to null the error signal. Because of pressure fluctuations created by rotor downwash, barometric altitude hold shall not be used to HIGE.

2-108. Heading Select.

Heading select is engaged when the HDG button on the AFCS panel (fig. 2-23) is pressed, the ENGAGED light is on, and a CMD SEL on one of the HSI mode select panels is pressed. The heading select cursor (bug) on the selected horizontal situation indicator is the referenced heading. Rotating the HDG knob of the HSI to set the bug at a new referenced heading produces an error signal which is processed by the AFCS computers and applied to the roll ilca. The roll ilca then moves to produce a standard rate turn at a maximum bank angle of 20° until the selected heading is captured. Heading select can only be selected at airspeeds above 40 knots. Heading select is disengaged anytime a CENTERING DEVICE RELEASE button is pressed or the pedals are moved.

2-109. Longitudinal Cyclic Trim System.

Longitudinal cyclic trim (lct) control is part of AFCS. Lct reduces fuselage nose down attitude as forward airspeed and altitude is increased, thus reducing fuselage drag. The system also reduces rotor blade flapping which results in lower stresses on the rotor shafts. The lct actuators are installed under the swashplates. Signals are transmitted to these actuators either automatically by AFCS, or manually by CYCLIC TRIM switches on the AFCS panel. In AUTO mode, No. 1 AFCS controls the forward actuator; No. 2 AFCS controls the aft actuator. Proximity switches drive the actuators to ground operating position (GND) on ground contact.

2-110. Controls and Indicators.

2-111. AFCS Control Panel. The AFCS control panel (fig. 2-23) is on the canted console. It consists of three sections: an AFCS system select section, a cyclic trim section, and the altitude and heading select section.

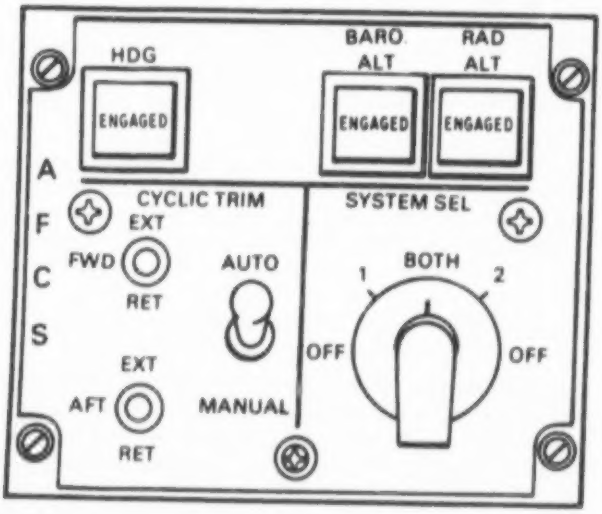


Figure 2-23. Advanced Flight Control System Panel

2-112. AFCS System Select Switch. The AFCS system select switch is a five position rotary switch. It is marked SYSTEM SEL and the switch positions are marked BOTH, 1, 2 and two OFF positions. Normally, the switch is at BOTH. In this position, both AFCS are operating at one-half gain. If one system should fail, the good system is selected and that system operates at ¾ gain. At OFF, both systems are inoperative except for cyclic trim.

2-113. Cyclic Trim Switches. One switch selects the mode of cyclic trim operation. Two additional switches extend or retract the forward and aft cyclic trim actuators. The mode switch is a two-position switch marked AUTO and MANUAL. Normal switch position is AUTO. If the cyclic trim actuators fail to extend or retract as indicated on the CYCLIC TRIM indicators, MANUAL mode can be selected. In MANUAL mode, the actuators can be controlled with separate FWD and AFT actuator control switches, using the airspeed indicator and the CYCLIC TRIM indicators.

2-114. Cyclic Trim Indicators.

WARNING

If the longitudinal cyclic trim actuators fail at the full retract position, or are manually selected to the full retract position, do not exceed the airspeed limitations shown in fig. 7-73.

The two CYCLIC TRIM indicators are on the center instrument panel. The indicators are marked RET, EXT 60 to 150 knots. In addition a GND position is marked for ground operations. The indicators display position of the forward and aft cyclic trim actuators relative to airspeed. During ground operations, they indicate activation of the squat switches.

2-115. AFCS OFF Caution Lights.

Two amber AFCS OFF caution lights (fig. 2-46) are on the master caution panel. Marked No. 1 AFCS OFF and No. 2 AFCS OFF, these lights come on when the associated AFCS is manually shutoff or has failed. Both lights may come on momentarily accompanied by a slight pitch transient when the SYSTEM SEL switch is set to BOTH following AFCS off flight. This indicates that the dash actuator is running at a reduced rate to null an airspeed error signal developed during AFCS off flight.

2-116. Heading Switch.

The heading (HDG) switch is used in conjunction with CMD SEL switch on either HSI MODE SELECT panel and the bug on either horizontal situation indicator to select coupled turns. The switch can be used only when airspeed is above 40 knots. When the switch is depressed and either CMD SEL switch depressed, the helicopter will automatically turn to and capture the bug heading on the selected hsi. When the switch is depressed, the ENGAGED legend will light. The switch is disengaged by pressing it again. Heading intercept will be at a standard rate of 3° per second up to a bank angle limit of 20° at 133 knots. The helicopter must be trimmed prior to engaging the mode and cyclic control inputs must be avoided except for longitudinal beep inputs to adjust airspeed. Heading select is disengaged if either CENTERING DEVICE RELEASE button is pressed.

2-117. Command Select Switches. The CMD SEL switches are on the pilots and copilots HSI MODE SELECT panels (fig. 3-7). Each switch is a two-position switch which is electrically held depressed when the switch is pressed. The switches are used to select the hsi which will provide the referenced heading when automatic turns is selected. Only one CMD SEL switch may be selected at the same time. If the other CMD SEL switch is selected during automatic turns, the HDG button on the AFCS panel will release and automatic turns will be disabled until one CMD SEL switch is selected and the HDG switch is again depressed. When selected, the SEL legend on the switch is lit.

2-118. BARO ALT and RAD ALT Switches.

The BARO ALT and RAD ALT are two-position switches which select altitude hold mode. An interlock prevents both switches from being depressed at the same time. When depressed, the ENGAGED legend will light. Radar altitude hold is used for hovering below 1,500 feet. Barometric altitude hold is used in forward flight to maintain a constant cruise altitude or may be used in HOGE.

2-119. Advanced Flight Control System (AFCS) Operation.

1. AFCS control panel (fig. 2-23) — Set as follows:

(a) SYSTEM SEL switch — BOTH.

(b) CYCLIC TRIM switch — AUTO.

(c) HDG, BARO ALT, and RAD ALT ENGAGED lights — OUT.

2. HEADING select.

(a) Be sure gyrosyn compass is synchronized. (Indicator pointer on the compass control panel alined with center mark.)

(b) Rotate HDG knob on the hsi that is to be used for the referenced heading until the cursor (bug) is alined with chosen heading.

(c) Trim helicopter straight and level (center ball on turn and slip indicator) and trim forces (depress CENTERING DEVICE RELEASE).

(d) CMD SEL switch on HSI MODE SELECT panel — Press. Check switch is depressed and SEL legend is lit.

(e) AFCS HDG — Press. Check ENGAGED light on. The helicopter will now turn to and capture the heading.

(f) Heading can be changed by rotating the cursor (bug) to the new heading. The helicopter will then turn to the new heading.

NOTE

> Pressing either centering device release disengages automatic turns.

3. BAROMETRIC ALTITUDE HOLD. Barometric altitude hold is selected to hold a constant altitude.

CAUTION

> Large pitch inputs will result in rapid gain or loss of altitude. If altitude hold is on, an overtorque condition can occur during large pitch-down inputs. Monitor thrust control movement and torquemeter during airspeed changes. Also, when operating with altitude hold, limit bank angles to 45 degrees maximum. An excessive bank angle may result in an altitude loss, and if operating at a high gross weight, an overtorque condition.

(a) When at chosen cruise altitude and airspeed, press BARO ALT switch on AFCS control panel. Check that ENGAGED light is ON. The helicopter will now maintain the selected altitude.

(b) To change altitude, press BARO ALT switch. Check ENGAGED light out. Fly helicopter to desired altitude. Then press BARO ALT switch. Check ENGAGED light ON. Helicopter will now maintain the selected altitude. As an alternate procedure, press the THRUST CONT BRAKE TRIGGER. Fly the helicopter to the desired altitude, then release the THRUST CONT BRAKE TRIGGER. The helicopter will remain at the altitude at which the trigger was released.

4. RADAR ALTITUDE HOLD.

WARNING

> Do not use radar altitude hold in forward flight. It may not provide adequate terrain clearance in rapidly changing terrain. Use radar altitude hold to maintain a constant absolute altitude during hover only. It can be used to a maximum of 1,500 feet absolute altitude.

(a) Radar altimeter — ON. Check that pointer has rotated from behind the mask, the digital display is lit, and the OFF flag is out of view.

(b) Fly to desired hover altitude. Set hover power.

(c) RAD ALT select on AFCS panel — Press. Check ENGAGED light ON. The radar altitude hold feature of the AFCS will maintain a constant hover altitude.

(d) To select another hover altitude press the THRUST CONT BRAKE TRIGGER. Fly to desired altitude and release the THRUST CONT BRAKE TRIGGER. The altitude at the moment the trigger is released will be the new hover altitude.

SECTION VI HYDRAULIC SYSTEMS

2-120. Hydraulic Power Supply System.

The hydraulic power supply system is made up of three separate systems: a No. 1 flight control system, a No. 2 flight control system, and a utility system. Each system includes a separate variable delivery pump, a reservoir cooler, and a pressure control module. Each flight control system is connected to the utility system by a power transfer unit. All systems are serviced by a common fill module and are pressurized to prevent pump cavitation.

2-121. Flight Control Systems.

The flight control systems consist of two identical systems: No. 1 flight control system and No. 2 flight control system. The flight control systems are parallel in operation, hydraulically separated, and electrically integrated. They operate at approximately 3,000 psi, reduced to 1,500 psi for the integrated lower control actuators. The flight control systems power four dual upper boost actuators (3,000 psi) and four dual integrated lower control actuators. Each flight control system powers one piston of each actuator.

No. 1 flight control system is pressurized by a pump on the forward transmission. No. 2 system is pressurized by a pump on the aft transmission. The power control modules consist of pressure-operated valves and pressure-line and return-line filters. No. 1 system power control module is in the forward pylon. No. 2 system power control module is in the aft pylon. Each power control module also includes an accumulator. The accumulator dampens low frequency pressure surges and provides stored hydraulic power for peak loads.

The power transfer unit in each system allows ground checkout of the flight control systems with the rotors stopped. Each power transfer unit consists of a pump driven by a hydraulic motor which is pressurized by the utility hydraulic system. The power transfer units are controlled by the POWER XFR switches on the HYDRAULIC panel in the overhead switch panel.

2-122. Hydraulic Flight Control Switch. A three-position center locked hydraulic flight control switch is on the HYDRAULIC panel in the overhead switch panel (figure 2-24). The switch is marked FLT CONTR. The switch positions are NO. 1 ON, BOTH, and NO. 2 ON. This switch can be used to turn off one of the flight control systems, provided the other one is operating. Turning off one of the flight control hydraulic systems disables the corresponding AFCS and causes the remaining AFCS to make full corrections. In addition, the respective AFCS OFF and HYD FLT CONTR caution lights will come on. Under normal flight conditions, with both NO. 1 and NO. 2 hydraulic flight control systems functioning, the hydraulic flight control switch is set to BOTH. The switch shall be set to NO. 1 ON or NO. 2 ON to render the other hydraulic flight control system inoperative following a malfunction in that system.

At BOTH, both solenoid valves are deenergized open and both flight control systems are pressurized. When the FLT CONTR switch is set to NO. 1 ON, the two-way solenoid valve on No. 2 power control module is energized closed. This causes No. 2 pressure-operated valve to close, depressurizing No. 2 system. When the FLT CONTR switch is moved to NO. 2 ON, the two-way solenoid valve on No. 2 power control module is deenergized open, and No. 2 system is pressurized. Simultaneously, No. 1 solenoid valve closes and No. 1 system is turned off.

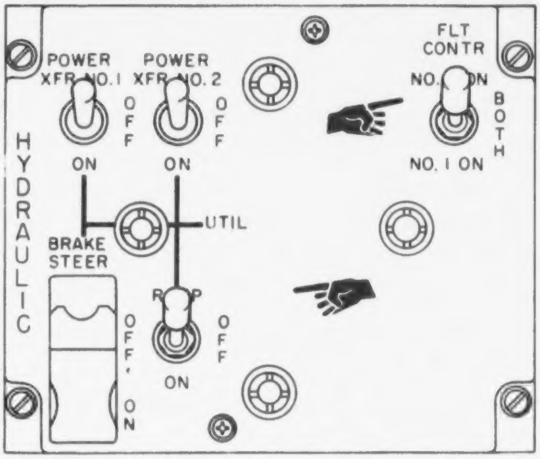


Figure 2-24. Hydraulics Control Panel

2-123. Utility Hydraulic System.

The utility hydraulic system supplies hydraulic power to the wheel brakes, the power steering actuator, the swivel locks, the centering cams, the ramp actuating cylinders, the hydraulic cargo door motor, the actuator for the center cargo hook, the cargo/rescue winch control valve, the two engine starters, the power transfer units, and apu start circuit. When the apu is running, the utility hydraulic system is pressurized by an apu driven pump. When the apu is not running, the utility hydraulic system is pressurized by an aft transmission driven pump. The utility hydraulic system incorporates a pressure control module which isolates utility subsystems from each other. When a failure occurs in one utility hydraulic subsystem, the remaining subsystems continue to operate normally if the isolation switches in the cockpit are set to OFF. (Refer to para 2-126 and 2-127.) The starting subsystem of the utility hydraulic system includes three accumulators which accelerate the apu to start, maintain reservoir pressure throughout the start cycle, and control operation of the APU motor pump. The apu starting subsystem also includes a two-stage hand pump for charging the apu start accumulators. The apu accumulator is normally recharged by the apu motor-pump after the apu is started. An additional accumulator in the brake system provides for limited brake operation in the event of utility hydraulic system failure. The steering system also has an accumulator to keep the swivel locks engaged when the BRAKE STEER switch is OFF.

Normal operating pressure for the utility hydraulic system is 2850 to 3100 psi. During the apu operation the pressure is increased to approximately 3350 psi for engine starting. See table 2-2 for flight control and utility hydraulic system capacities and Chapter 7 for accumulator precharge pressures.

2-124. Power Transfer Unit Switches. The upper two switches on the utility hydraulic portion of the HYDRAULIC control panel (fig. 2-24) are marked POWER XFR NO. 1 and POWER XFR NO. 2. Each switch has two positions: ON and OFF. When the apu is operating and either switch in ON, 28-volt dc opens the normally closed solenoid valve in the corresponding power transfer unit and opens a valve in the pressure control module. This allows utility hydraulic system pressure to operate the hydraulic motor pump on that power transfer unit, pressurizing the flight control hydraulic system. Consequently, the flight controls can be operated on the ground for maintenance and checks without the rotors turning. When both switches are ON, both hydraulic motor pumps of the power transfer units supply pressure for flight control operation. When the switches are OFF, the solenoid valves are closed, and the flight controls cannot be operated unless the rotors are turning. Power for these switches is supplied from the 28-volt No. 2 dc bus thru PWR XFER circuit breaker on the No. 2 power distribution panel.

2-125. Ramp Isolation Switch.

WARNING

> When the RAMP isolation switch is at OFF, be sure the RAMP CONTROL VALVE is not moved from STOP. Operating the valve from STOP to UP or DN may cause the ramp to free fall.

The RAMP isolation switch is on the lower right side of the utility hydraulic portion of the HYDRAULIC control panel (fig. 2-24). The switch has two positions, marked ON and OFF. At ON, the ramp isolation valve in the utility system pressure control module is open, allowing system pressure for normal ramp operation. At OFF, the ramp isolation valve is closed, isolating the ramp system from the remaining utility systems. This prevents loss of utility system fluid if the ramp system fails. The RAMP switch and valve receive 28-volt power from No. 1 dc bus thru the UTIL SYS CONT circuit breaker on No. 1 power distribution panel.

2-126. Brake Steer Switch. The BRAKE STEER switch is on the HYDRAULIC control panel (fig. 2-24) on the overhead switch panel. It is a guarded two-position switch marked ON and OFF. At ON, the brake and steering isolation valve in the utility system pressure control module is open, allowing system pressure for normal brake and steering operation. At OFF, the brake and steering isolation valve is closed, isolating the brake and steering subsystems from the remaining utility systems. ON is the normal flight position. OFF is used when there has been a hydraulic failure in the brake or steering system. Setting the switch OFF in this case prevents loss of system fluid. This allows the remaining utility subsystems to continue to function normally. The brake system contains an accumulator which allows limited system operation in a hydraulic failure. The swivel lock system also has a small accumulator which keeps the swivel locks locked with the system isolated. The BRAKE STEER switch and valve receive power thru the BRAKE STEER circuit breaker on No. 1 power distribution panel.

2-127. Hydraulic System Service Module.

A service module, on the right side of the cargo compartment above the ramp, provides for filling the two flight control hydraulic systems and the utility hydraulic system. It consists of a filler assembly, a single-stage hand pump, and a selector valve for selection of any of the three hydraulic systems for filling.

2-128. Utility System Hand Pump

A two-stage hand pump, on the right side of the cargo compartment above the ramp, is used to pressurize the apu start accumulators for apu starting. The EMERG UTIL PRESS controllable check valve next to the pump is used with the hand pump to operate the ramp and hatch. NORMAL position of the check valve is used when the system is pressurized by the apu or by the utility hydraulic pump. When the engines and the apu are not operating, the controllable check valve is set to OPEN, the ramp control handle is set to UP or DN, and the hand pump is operated. When ramp movement is completed, the ramp control handle is set to STOP and the controllable check valve is set to NORMAL.

2-129. EMERG UTIL PRESS Controllable Check Valve

The EMERG UTIL PRESS controllable check valve allows apu start accumulator pressure to be used for operation of the ramp or any other subsystem (brakes, swivel locks, etc.). When the apu motor pump or utility pump is not operating, it is not necessary to use the hand pump unless the accumulator is discharged. This valve may also be used in flight, in the event of utility pump or system failure to provide accumulator pressure to the subsystems.

2-130. Hydraulic Pressure Caution Lights. Three hydraulic pressure caution lights, one for each flight control system and one for the utility hydraulic pressure system, are on the master caution panel (figure 2-46). The lights are marked NO. 1 HYD FLT CONTR, NO. 2 HYD FLT CONTR, and UTIL HYD SYS. Each light is electrically connected to a pressure switch in the corresponding control module. Whenever hydraulic pressure drops below 1,800 psi in one of the flight control systems or the utility system, that system caution light comes on. The caution light goes off as increasing pressure approaches 2,300 psi. Caution light operation is independent of hydraulic pressure indicator operation. Power to operate these lights is supplied from the 28-volt dc essential bus thru the CAUTION PNL circuit breaker on No. 1 power distribution panel.

2-131. Hydraulic Pressure Indicators. Three hydraulic pressure indicators (figure 2-27), one for each hydraulic system, are on the maintenance panel. Each indicator is electrically connected to a corresponding pressure transmitter on each power control module. Power to operate these indicators is supplied from the 28-volt No. 2 dc bus thru the HYDRAULICS PRESS IND circuit breaker on No. 2 power distribution panel.

SECTION VII POWER TRAIN SYSTEM

2-132. General.

Engine power is supplied to the rotors thru a mechanical transmission system. (See figure 2-1.) This system consists of a forward, an aft, a combining, two engine transmissions and drive shafting. An overrunning sprag clutch is installed in each engine transmission. The clutch provides a positive drive connection to transmit power and permits freewheeling of both rotors, in autorotation during actual or simulated power failure. Because of the freewheeling feature, no drag will be placed on the rotors if an engine (or engines) or engine transmission fails. Power from the engine transmissions is transmitted thru separate drive shafts to the combining transmission. The combining transmission combines the power of the engines and transmits it at reduced shaft speed to the forward and aft transmissions. Further speed reduction occurs within the rotor transmissions.

Two ac generators, the No. 2 flight control hydraulic pump, and the utility system pump are mounted on and driven by the aft transmission. The No. 1 flight control hydraulic pump is mounted on and driven by the forward transmission.

2-133. Transmission Lubrication Systems.

The forward, aft, and combining transmissions each include independent main and auxiliary lubrication systems which operate concurrently. Refer to table 2-3 for transmission oil system capacities, oil specifications, and servicing procedures.

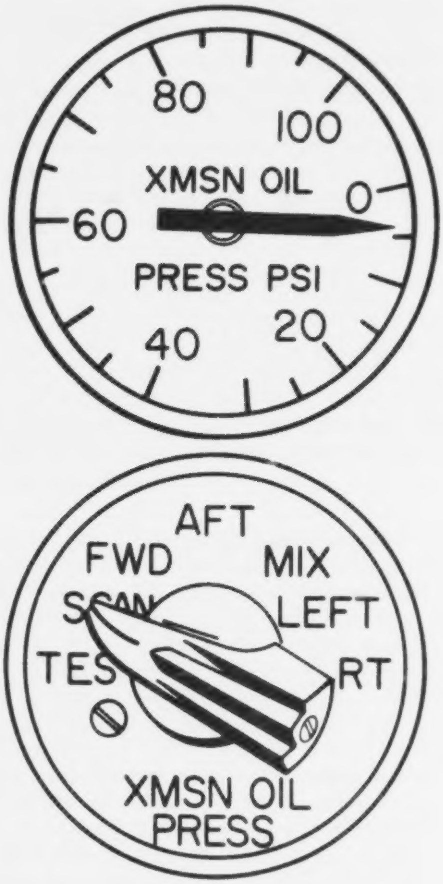
2-134. Forward Transmission. The forward transmission lubrication system supplies lubricating oil to the gears and bearings in the forward transmission. Main system oil flows from the sump, thru the main oil pump, oil filter, cooler, and a jet protection screen to jets from which the oil is discharged to the various gears and bearings. Auxiliary system oil flows from the auxiliary sump thru the auxiliary oil pump, and the auxiliary system filter to separate AUX OIL jets. The main system filter has an impending bypass indicator. The bypass indicator extends if the pressure drop across the filter exceeds 15 to 18 psi, which may indicate a partially clogged filter. An oil cooler mounted on the aft end of the transmission around the input pinion cools main system oil. Air is forced thru the cooler by a transmission-driven fan.

2-135. Aft Transmission. The aft transmission lubrication system supplies lubricating oil to the various gears and bearings in the aft transmission and to the aft rotor shaft bearing. In addition, the main lubrication system circulates cooling oil thru the two ac generators on the aft transmission. Transmission oil flows from the sump thru the main lube pump, main filter, cooler, and the jet protection screen to jets where the oil is sprayed onto the various gears and bearings. In addition, after the oil leaves the jet protection screen, alternate paths routes some of the lubricating oil to the aft shaft bearing and cooling oil to the generators. Auxiliary system oil flows from the auxiliary sump thru the auxiliary pump and filter to the various gears and bearings. Separate oil jets are utilized for each oil system. The auxiliary system does not lubricate the aft shaft bearing or the generators. An oil cooler mounted on the aft end of the transmission cools main system oil. Cooling air is drawn thru the cooler by a transmission-driven fan. The main system filter has an impending bypass indicator. The bypass indicator extends if the pressure drop across the filter exceeds 15 to 18 psi, which may indicate a partially clogged filter.

2-136. Combining and Engine Transmission Lubrication Systems. Combining transmission oil flows from the sump thru the main pump, main filter, cooler, and jet protection screen to the various gears and bearings and No. 1 engine transmission. Auxiliary system oil flows from the auxiliary reservoir thru the auxiliary pump and auxiliary filter to the various gears and bearings. Separate oil jets are utilized for each oil system. Two scavenge pumps return the oil to the reservoir from the transmission sump. The combining transmission filter has an impending bypass indicator. If the pressure drop across the filter exceeds 15 to 18 psi, the bypass indicator will extend. This may indicate a partially clogged filter. Engine transmission oil flows from the reservoir thru the pump, filter, cooler, and jet protection screen to the jets which spray the oil onto the various gears and bearings. A scavenge pump returns the oil from the transmission sump thru an indicating screen and back to the reservoir. Engine transmissions do not have auxiliary lubrication systems. All engine transmission lubrication system components except the jet protection screens and jets are on the combining transmission. The engine transmission filter has an impending bypass indicator. If the pressure drop across the filter exceeds 15 to 18 psi, the bypass indicator extends, which may indicate a partially clogged filter. The individual oil coolers for the combining and both engine transmissions are mounted on the combining transmission and utilize a common transmission driven fan for cooling air.

2-137. Transmission Main Oil Pressure Indicator.

A transmission main oil pressure indicator (fig. 2-25), on the center section of the instrument panel, indicates either the lowest main oil pressure in any one of the transmissions or only the oil pressure in the transmission selected by the pilot. The indicator is electrically connected to each transmission. Ac power (115-volt) operates this unit. A circuit breaker for the indicator is on No. 1 power distribution panel and is marked XMSN OIL PRESS. Each transmission and aft rotor shaft bearing also incorporate a separate low pressure switch. These switches are connected to the XMSN OIL PRESS caution light.



NOTE:
REFER TO CHAPTER 5 FOR INSTRUMENT MARKINGS.

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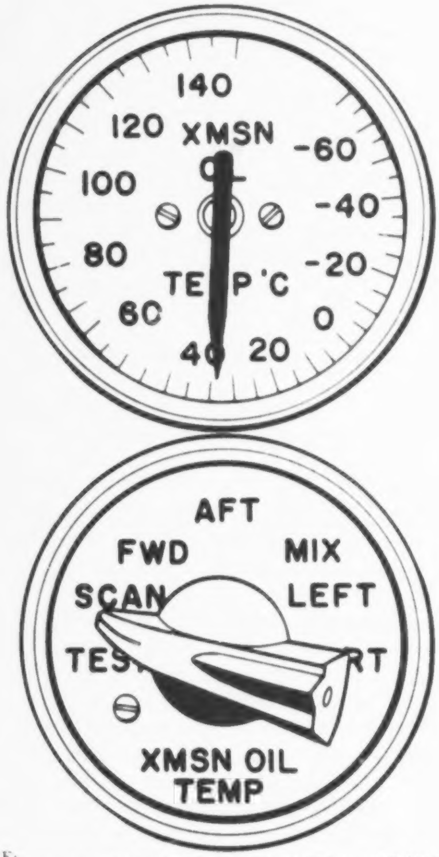
Figure 2-25. Transmission Main Oil Pressure Switch and Indicator

2-138. Transmission Main Oil Pressure Selector Switch. A transmission oil pressure selector switch (fig. 2-25) is on the center section of the instrument panel. The switch positions are TEST, SCAN, FWD, AFT, MIX, LEFT, and RT. When the switch is set to TEST, the pointer on the transmission pressure indicator will drop to zero or below. When the switch is set to SCAN, the lowest main oil pressure among all the transmission will be indicated. The remaining positions are used to select a particular transmission oil pressure indication. When selecting a particular switch position, be sure the switch is in detent. If the switch is not in detent, the pressure gage will indicate zero.

2-139. Transmission Main Oil Temperature Indicator.

A transmission oil temperature indicator (fig. 2-26) on the center section of the instrument panel reads from -70° to + 150°C. It indicates the highest oil temperature among all the transmissions or only the oil temperature of the selected transmission. Wires connect the indicator and amplifier to a temperature probe in the forward and aft transmission sumps and in each compartment of a three-compartment oil tank for the combining transmission and each engine transmission. The temperature probes in the three tank compartments measure oil temperature in the tank and may not immediately indicate a transmission problem. Loss of oil or low oil pressure may not be accompanied by a high oil temperature indication. Power to operate this unit is supplied by No. 1 115-volt ac bus thru a circuit breaker marked XMSN OIL TEMP on No. 1 power distribution panel. Each temperature probe incorporates a high oil temperature switch which is independent of the temperature indicator and is triggered at 140°C, lighting the XMSN OIL HOT caution light.

2-140. Transmission Main Oil Temperature Selector Switch. A transmission oil temperature selector switch (fig. 2-26) is on the center section of the instrument panel



NOTE: REFER TO CHAPTER 5 FOR INSTRUMENT MARKING.

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Figure 2-26. Transmission Main Oil Temperature Switch and Indicator

below the transmission oil temperature indicator. The switch positions are TEST, SCAN, FWD, AFT, MIX, LEFT, and RT. When the switch is set to TEST, the pointer on the transmission oil temperature indicator deflects full scale toward low temperature. The highest oil temperature among all transmissions is indicated. The remaining positions are used for selecting a particular transmission oil temperature indication. When selecting a particular switch position, be sure the switch is in detent. If the switch is not in detent, the oil temperature indicator will indicate −70°C.

2-141. ***Transmission Oil Caution Lights.*** Five transmission oil caution lights are on the master caution panel. The lights are marked XMSN OIL HOT, XMSN OIL PRESS, XMSN AUX OIL PRESS, and NO. 1 and NO. 2 ENG XMSN HOT. These lights, in conjunction with the transmission oil pressure and temperature indicators on the instrument panel alert the crew to impending transmission lubrication problems. The caution lights operate independently of the pressure and temperature indicators on the instrument panel. The XMSN OIL HOT light comes on when the main oil temperature in the reservoir of the forward, aft, combining, or either engine transmission exceeds 140°C. The hot transmission is identified by the oil temperature selector switch and indicator.

The XMSN OIL PRESS caution light comes on when main oil pressure drops below 20 psi in any transmission or aft rotor shaft pressure drops below 10 psi. The low-pressure system is identified by the transmission oil pressure selector switch and indicator on the instrument panel. If the XMSN OIL PRESS caution light comes on and the affected transmission cannot be determined using the selector switch, the condition may be caused by loss of aft rotor shaft oil pressure. Low oil pressure at the aft rotor shaft is indicated by the illumination of the AFT SHAFT light on the maintenance panel.

The XMSN AUX OIL PRESS caution light which is activated by individual aux oil switches, comes on when auxiliary oil pressure drops below 20 psi in the fwd or aft transmission and 10 psi in the combiner transmission. The transmission with the low pressure is identified by a lit AUX OIL PRESS indicating light on the maintenance panel.

The NO. 1 or NO. 2 ENG XMSN HOT caution lights come on if oil temperature in either engine transmission exceeds about 190°C. The lights are turned on by a thermoswitch in each engine transmission. The thermoswitch monitors oil temperature in the transmission, not in the reservoir. The thermoswitch is part of a chip detector and temperature assembly in each engine transmission.

2-142. ***Transmission Chip Detectors.*** Chip detectors are installed in all transmission and aft rotor shaft thrust bearing lubrication systems. All chip detectors, except those in the engine transmission, are connected to the XMSN CHIP DET caution light on the master caution panel. Engine transmission chip detectors are connected to the ENG CHIP DET caution lights. All transmissions and the aft rotor shaft chip detectors are also connected to the TRANSMISSION CHIP DETECTOR indicators on the maintenance panel (fig. 2-27). When a chip detector is bridged by ferrous particles, the XMSN CHIP DET, or ENG CHIP DET caution light comes on. At the same time, the corresponding TRANSMISSION CHIP DETECTOR indicator on the maintenance panel will trip and change from an all-black indication to a black-and-white indication, identifying the transmission.

SECTION VIII ROTOR SYSTEM

2-143. General.

Lift is produced by a rotor system consisting of two fully articulated counter-rotating rotors. Each rotor has three fiberglass blades. The forward rotor is driven by the forward transmission thru a rotor drive shaft. The aft rotor is driven by the aft transmission thru a vertical drive shaft. The rotor head consists of a hub connected to three pitch-varying shafts by three horizontal hinge pins. These pins permit blade flapping. Stops on the top and the bottom of the hub limit the blade flapping motion. The aft rotor head is equipped with centrifugal droop stops which provide increased blade flapping angle for ground and flight operation. Covers are installed on the centrifugal droop stop operating mechanism. The covers prevent ice accumulation on the mechanism and ensure proper droop stop operation following flight in icing conditions. For information on use of the droop stop covers, refer to Chapter 8, Section IV. Mounted coaxially over the pitch-varying shafts are pitch-varying housings to which the blades are attached by vertical hinge pins. These pins permit blade leading and lagging. Each pitch-varying shaft is connected to the pitch-varying housing by a laminated tie bar assembly. The high tensile strength and low torsional stiffness of the tie bar retains the blade against centrifugal force and allows blade pitch changes about the pitch axis. Blade pitch changes are accomplished by three pitch-varying links connected from the rotating ring of the swashplate to the pitch-varying housing on each rotor blade. Cyclic pitch changes are accomplished by tilting the swashplate. Collective pitch changes are realized by vertical movement of the swashplate. Combined collective and cyclic pitch changes result from combined control inputs by the pilot. A direct-action shock absorber is attached to the blade and to the pitch-varying housing. When the inboard end of the shock absorber is disconnected, the blade can be folded in either direction about the vertical hinge pin.

2-144. *Rotor Blades.*

a. Each rotor blade consists of a D-shaped fiberglass spar assembly and a Nomex fairing assembly bonded to the spar. The blade chord is 32 inches.

b. A titanium nose cap is bonded to the leading edge of the spar. A nickel erosion cap is bonded to the blade along the outer 54 inches of leading edge. This cap protects the part of the blade most vulnerable to erosion.

c. The fairing assembly is bonded to the trailing edge of the spar. These fairings are constructed of a Nomex honeycomb core covered with a fiberglass skin. Wire mesh screens are embedded in the fiberglass skin at the tip and the trim tab. The wire mesh screens provide an electrical path to the rotor hub from the metal trim tab and tip for lightning protection. Also, to provide lightning protection, each blade has two lightning protection cables and two straps. The cables and straps complete the path from the wire mesh to the rotor head.

d. Balance and tracking weights are installed in the tip of spar and fairing assembly. The tracking weights are removable and are used for blade tracking.

2-145. *Rotor Tachometers.*

Two rotor tachometers (16 and 54, fig. 2-7), one mounted on the pilot's instrument panel, the other mounted on the copilot's instrument, indicate percent of rotor rpm. A small needle on the tachometer indicates percent rpm from 0 to 60. The large needle indictes percent rpm from 60 to 130. The rotor rpm sense signal is supplied by the ac generators. Generator No. 1 supplies the copilot's indicator; generator No. 2 supplies the pilot's indicator. Power to operate the indicators is from the essential bus thru the ROTOR TACH circuit breaker on both power distribution panels.

SECTION IX UTILITY SYSTEMS

2-146. Anti-Icing Systems.

Anti-icing is provided for the engine air inlet fairing, engine transmission fairing, and engine drive shaft fairings (structural anti-icing). Also, the pitot tubes, AFCS yaw ports, and windshields are anti-iced.

2-147. *Structural Anti-Icing.*

Hot air anti-ices the engine air inlet fairing, engine transmission fairing, and the drive shaft fairing. Hot air is tapped from the engine air bleed gallery thru a fairing hot air valve and ducted to the fairings. When the fairing hot air valve is open, the air travels to the leading edge of the fairings, circulates, and escapes thru small holes in the trailing edges. Anti-icing is controlled by the engine anti-ice switch and a fairing hot air valve. Refer to para 2-42 for a description of the engine anti-icing system.

2-148. *Pitot Tube and AFCS Sideslip Port Anti-Icing.*

Heating elements prevent ice accumulation in the pitot tubes and the yaw ports. Power to operate the heaters is supplied by the 115-volt No. 2 ac bus thru two circuit breakers marked PITOT HEAT and YAW PORT HEAT. The breakers are on No. 2 power distribution panel.

2-149. Pitot Heat Switch. A two-position toggle switch on the anti-ice control panel (fig. 2-8) of the overhead switch panel is marked PITOT. The ON position provides power to the heater elements in the pitot tubes and yaw ports. When the switch is moved to OFF, the heating elements are deenergized.

2-150. *Windshield Anti-Icing.*

The pilot's and copilot's windshields are anti-iced and defogged electrically. The center windshield is defogged but not anti-iced. The laminated windshield panels are heated electrically by current which passes thru a transparent conductive coating imbedded between the layers. The temperature of each individual windshield is automatically maintained by a temperature controller which operates in conjunction with a sensor element imbedded in the windshield and a temperature control relay. The switches for the windshield anti-icing system are on the ANTI-ICE control panel (fig. 2-8) of the overhead switch panel. Power for the pilot's and center windshields is from the 115-volt No. 2 ac bus thru the WSHLD ANTI-ICE PILOT and CTR HEAT circuit breakers. Power for the copilot's windshield is from the 115-volt No. 1 ac bus thru the WSHLD COPLT HEAT circuit breaker on No. 1 power distribution panel. Anti-ice control for the pilot's and center windshield is from the 28-volt No. 2 dc bus thru the WSHLD ANTI-ICE CONT CTR and PILOT circuit breakers on No. 2 power distribution panel. Anti-ice control for the copilot's windshield is from the 28-volt No. 1 dc bus thru the WSHLD COPLT CONT circuit breaker on No. 1 power distribution panel.

2-151. *Windshield Anti-Ice Switches.*

CAUTION

> If windshield bubbling or delamination occurs around the sensor element, immediately set the switch to OFF for that windshield.

Three two-position toggle switches control the application of heat to the pilot's, copilot's, or center windshield. The switches (fig. 2-8) are marked WINDSHIELD PLT, CPLT, and CTR. When either switch is moved to ON, current flows to the associated temperature controller and then to the windshield. When the temperature of the windshield rises to a preset value (about 44°C), as sensed by the sensor element, the electrical current to the windshield is interrupted by the temperature control relay. Once the windshield has cooled sufficiently, electrical current is reapplied. This causes a cycling effect which maintains windshield temperature within operating limits. Operating temperature is reached in less than 1 minute after the switch is moved to ON. When the switch is set to OFF, the anti-icing system is deenergized.

2-152. Miscellaneous Equipment.

Paragraphs 2-164 thru 2-175 describe other equipment available to the crew members.

2-153. Maintenance Panel.

The maintenance panel (fig. 2-27) is on the right side of the cabin above the ramp. The panel is provided to assist in the identification of system conditions that may require servicing or other maintenance. The panel is divided into three sections: TRANSMISSIONS, HYDRAULICS, and ENGINE. It may also have left and right ground contact annunciator lights adjacent to the ENGINE section.

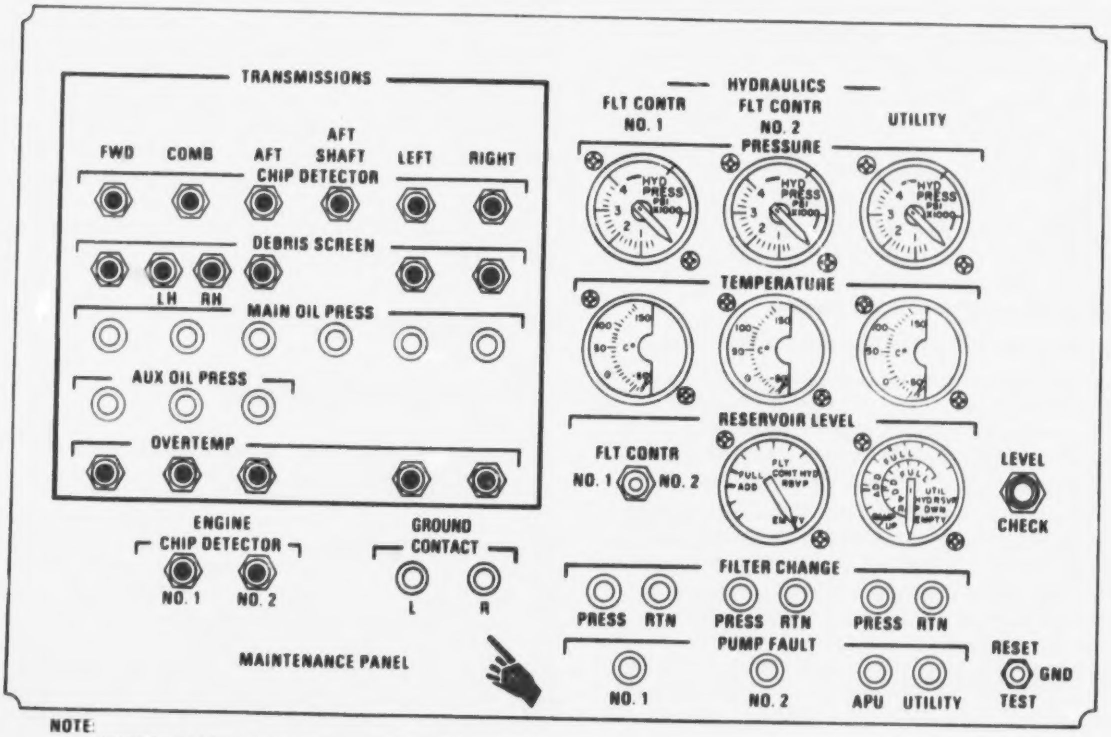
a. The TRANSMISSIONS section of the panel includes nine oil pressure lights, six chip detector magnetic indicators, six debris screen magnetic indicators, and five overtemperature magnetic indicators.

b. The HYDRAULICS section of the panel consists of three PRESSURE indicators, three fluid TEMPERATURE indicators, two RESERVOIR LEVEL indicators, six FILTER CHANGE lights, and four PUMP FAULT lights.

c. The ENGINE section of the panel consists of two magnetic indicators labeled NO. 1 and NO. 2 ENGINE CHIP DETECTOR. The maintenance panel transmission indicators receive power from No. 1 dc bus thru the MAINT PNL circuit breaker on the No. 1 power distribution panel. The maintenance panel hydraulic indicators receive power from the No. 2 dc bus thru the MAINT PNL LTS circuit breaker on the No. 2 power distribution panel.

2-154. Hydraulic Pressure Indicators. Three hydraulic pressure indicators are on the HYDRAULICS section of the maintenance panel (fig. 2-27). They are marked FLT CONTR NO. 1, FLT CONTR NO. 2, and UTILITY PRESSURE. Each indicator is electrically connected to a corresponding pressure transmitter on each power control module. The indicators receive power from the 28-volt No. 2 dc bus thru the PRESS IND circuit breaker on No. 2 power distribution panel. Indicator operation is independent of caution light operation.

2-155. Fluid Temperature Indicators. Three fluid TEMPERATURE indicators are on the maintenance panel. The indicators are below the PRESSURE indicators. The indicators indicate the temperature of the hydraulic fluid at the outlet of the corresponding reservoir-cooler. The indicators receive power from the 28-volt No. 2 dc bus thru the HYDRAULIC FLUID TEMP circuit breaker of No. 2 power distribution panel.


TRANSMISSIONS
FWD
COMB
AFT
AFT SHAFT
LEFT
RIGHT
CHIP DETECTOR
DEBRIS SCREEN
LH
RH
MAIN OIL PRESS
AUX OIL PRESS
OVERTEMP
ENGINE CHIP DETECTOR
NO. 1
NO. 2
GROUND CONTACT
L
R
MAINTENANCE PANEL
HYDRAULICS
FLT CONTR NO. 1
FLT CONTR NO. 2
UTILITY
PRESSURE
HYD PRESS PSI X1000
TEMPERATURE
C°
RESERVOIR LEVEL
FLT CONTR
NO. 1
NO. 2
FULL
ADD
EMPTY
UTIL HYD RSVR
LEVEL
CHECK
FILTER CHANGE
PRESS
RTN
PRESS
RTN
PRESS
RTN
PUMP FAULT
NO. 1
NO. 2
APU
UTILITY
RESET
GND
TEST
12501

NOTE:
REFER TO CHAPTER 5 FOR INSTRUMENT LIMIT MARKINGS.

Figure 2-27. Maintenance Panel

2-156. Fluid Level Indicators. Two hydraulic fluid level indicators are on the HYDRAULICS section of the maintenance panel (fig. 2-27). The indicators are marked RESERVOIR-LEVEL and indicate the fluid level in each reservoir-cooler. When the LEVEL CHECK switch adjacent to the indicator is pressed. The flight control reservoir indicator serves both flight control hydraulic reservoirs. A two-position selector switch next to the indicator selects the fluid level to be indicated. The switch is marked FLT CONTR NO. 1 and NO. 2. The indicator dial is marked EMPTY, ADD, and FULL. The reservoir should be serviced to the FULL mark prior to flight.

2-157. Filter-Change Lights. Six filter-change PRESS-TO-TEST lights are on the maintenance panel (fig. 2-27). The lights are arranged in three sets of two. One set is for No. 1 flight control system. The second set is for No. 2 flight control system. The third set is for the utility system. The lights for each system are labeled FILTER CHANGE PRESS and RTN. The PRESS light in each set monitors the pressure line filter in each system. The RTN light monitors the return line filter in each system. When the pressure drop across a filter exceeds 75 psi, indicating impending filter bypass, the corresponding filter-change light will come on. The filter-change lights receive power from the 28-volt No. 2 dc bus thru the HYDRAULIC MAINT PNL LTS circuit breaker on No. 2 power distribution panel.

2-158. Pump-Fault Lights. Four pump-fault PRESS-TO-TEST lights are on the HYDRAULICS section of the maintenance panel (fig. 2-27). The lights are labeled PUMP FAULT NO. 1, NO. 2, APU, and UTILITY. The lights are connected to sensors in the case drain line of each pump. If the flow rate from the case drain of a pump increases to the point which causes an increased pressure drop across the sensor, the sensor turns on the corresponding pump-fault caution light. (A high flow rate from the case drain of a pump may indicate impending pump failure.) The pump-fault caution lights receive power from 28-volt No. 1 dc bus thru the MAINT PNL circuit breaker on No. 1 power distribution panel.

2-159. Chip Detector Indicators. Six CHIP DETECTOR magnetic indicators are on the TRANSMISSION section of the maintenance panel (fig. 2-27). The indicators are marked FWD, COMB, AFT, AFT SHAFT, LEFT and RIGHT. When the corresponding chip detector is bridged by ferrous particles, the associated chip detector indicator changes from all-black to black-and-white. At the same time, the XMSN CHIP DET or ENG CHIP DET caution light on the master caution panel comes on.

2-160. Oil Pressure Lights. Nine PRESS-TO-TEST oil pressure lights are on the TRANSMISSION section of the maintenance panel (fig. 2-27). Six lights marked MAIN OIL PRESS indicate low main oil pressure. Three lights marked AUX OIL PRESS indicate low auxiliary oil pressure. If main oil pressure drops below 20 psi in any transmission or 10 psi in the aft shaft bearing, the corresponding light comes on. At the same time, the XMSN OIL PRESS light on the master caution panel comes on. If auxiliary oil pressure drops below 20 psi in the forward or aft transmission, the associated AUX OIL PRESS light on the maintenance panel comes on. At the same time, the XMSN AUX OIL PRESS caution light on the master caution panel comes on. The AUX OIL PRESS lights on the maintenance panel are the only means of identifying the specific low-pressure auxiliary oil system.

2-161. Debris Screen Magnetic Indicators. Six transmission DEBRIS SCREEN magnetic indicators are on the maintenance panel (fig. 2-27). There is one indicator each for the forward, aft, engine No. 1, and engine No. 2 transmissions. There are two indicators for the combining transmission: one indicator for the left sump and one indicator for the right sump. The indicators are electrically connected to screens in the sumps of each transmission. If the screen mesh is bridged with conductive particles, the indicating circuit closes and trips the corresponding DEBRIS SCREEN magnetic indicator on the maintenance panel.

2-162. Transmission Oil Overtemperature Indicators. Five transmission oil OVERTEMP magnetic indicators are on the maintenance panel. Each OVERTEMP indicator is electrically connected to a temperature probe in the reservoir of each transmission. If oil temperature in the transmission reservoir exceeds 140°C, a switch closes. When the switch closes, the XMSN OIL HOT caution light comes on and the corresponding OVERTEMP indicator on the maintenance panel changes from all-black to black-and-white, identifying the hot transmission.

NOTE

> Operating the maintenance panel TEST switch in flight will cause caution panel lights to go on. The flight engineer shall alert the pilot when the TEST switch is used in flight.

2-163. Ground Test Switch. The BITE (Built In Test Equipment) test switch is on the lower right corner of the maintenance panel (fig. 2-27). The switch is marked GND TEST and RESET. The switch is spring-loaded and locked at center-off position. At TEST, a black and white display appears on all magnetic BITE indicators. At RESET, all magnetic BITE revert to an all-black indication. The switch is energized by the 28-volt No. 1 dc bus thru the MAINT PNL circuit breaker on No. 1 power distribution panel.

2-164. Windshield Wipers.

CAUTION

> To prevent windshield damage, do not operate windshield wipers when windshields are dry.

Two electrically driven windshield wipers (fig. 2-5) are installed, one on each pilot's windshield. One motor operates both wipers thru two flexible shafts and two windshield wiper converters. The windshield wiper motor is controlled by the windshield wiper switch and operated by current from the 28-volt No. 2 dc bus thru a circuit breaker marked WSHLD WIPER on No. 2 power distribution panel.

2-165. Windshield Wiper Control Switch. The W/S WIPERS control switch is on the lower left control panel of the overhead switch panel. The switch positions are marked OFF, SLOW, MED, FAST, and PARK. Wiper speed can be adjusted as desired, by rotating the switch from OFF. At OFF, the wipers will stop immediately at any position on the arc of travel. At PARK, the wipers stop and reposition against the inside windshield frame.

2-166. Map and Data Case.

The map and data case is in the passageway. It holds manuals, maps, and other data.

2-167. Cockpit Rearview Mirror.

A rearview mirror is installed on the right center windshield support to enable the pilot to observe the cargo compartment.

2-168. Spare Lamp Stowage Box.

The spare lamp stowage box is in the cockpit on top of the No. 1 power distribution panel. Spare lamps are provided for the instrument post lights, instrument light shields, dome lights, cabin and ramp lights, and nacelle work lights.

2-169. Cockpit Utility Receptacles.

Two 28-volt dc utility receptacles are in the cockpit, one on No. 1 power distribution panel and one on No. 2 power distribution panel. Each receptacle is marked UTIL RCPT 28 VDC. The copilot's receptacle is powered by the No. 1 dc bus thru the UTILITY COPLT circuit breaker on the No. 1 pdp. The pilot's receptacle is powered by the No. 2 dc bus thru the UTILITY RCPT PILOT circuit breaker on the No. 2 pdp.

2-170. Ac Cabin Utility Receptacles.

A 115 volt, single-phase 400 hertz ac utility receptacle and a 200 volt 3-phase 400 hertz ac utility receptacle are on each side of the cabin at sta 360. The receptacles are accessible after the acoustical access cover and the receptacle dust cap are removed. The 115 volt receptacles are powered from the No. 1 and No. 2 ac buses thru the LH and RH UTIL RCPT circuit breakers on each power distribution panel. The 200 volt receptacles are powered from the No. 1 and No. 2 ac buses thru the LH and RH CABIN AC RCPT 3-phase circuit breakers on each power distribution panel.

2-171. Dc Cabin Utility Receptacles.

Four 28-volt dc utility receptacles with three outlets are on the sidewalls of the cargo compartment. Each group of receptacles is rated at 15-amperes. The left cabin utility receptacles are powered by the 28-volt No. 1 dc bus thru two 15 ampere circuit breakers marked UTILITY, LH FWD, LH AFT, on the No. 1 power distribution panel. The right cabin utility receptacles are powered thru 28-volt No. 2 dc bus thru two 15 ampere circuit breakers marked UTILITY RCPT RH AFT and RH FWD on No. 2 power distribution panel.

2-172. Strobex Vibrex Blade Track Receptacle.

The Strobex Vibrex blade tracking and balancing receptacle (fig. 2-28) is in the cargo compartment at sta 256 right side. The receptacle, identified as BLADE TRACK, is used as the power and signal source for the equipment. The receptacle is powered by the 28-volt No. 2 dc bus thru the BLADE TRACK circuit breaker on the No. 2 power distribution panel.

2-173. Ash Trays.

Three ash trays are installed in the cockpit, one for each pilot and one for the troop commander.

2-174. Compass Correction Card Holder.

The magnetic compass correction card holder is attached to the left side of the magnetic compass. The card contains the necessary deviation values which are applied to the indicated reading.

2-175. Pilot's Assist Straps.

Two assist straps are attached to the center window frame of the cockpit structure to provide the pilots with a hand hold while getting into the seats. The assist strap can be positioned flat against the structure after use.

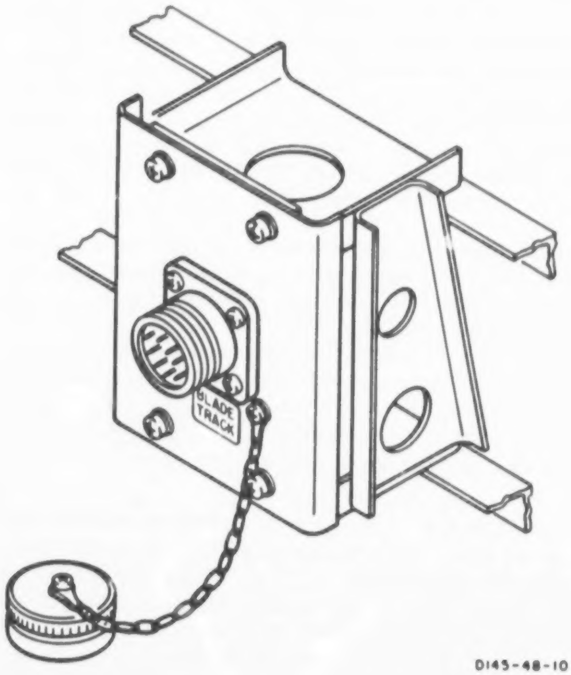


Figure 2-28. Strobex Vibrex Blade Track Receptacle

SECTION X HEATING, VENTILATION, COOLING, AND ENVIRONMENTAL CONTROL SYSTEMS

2-176. Heating and Ventilating System.

A 200,000 btu/hr-capacity internal combustion heating system is provided. It consists of a heater unit, a fuel control unit, an ignition assembly, a blower, control relays, and air pressure and temperature control circuits. Ducting carries heated air or ventilating air to the cockpit and the cabin. The heater consumes approximately 15 pounds per hour from the right main fuel tank. The heater and blower are mounted vertically on the right side of the helicopter, immediately aft of the forward cabin section bulkhead. Air for the system is provided by the blower which draws air from an inlet on the forward upper side of the fuselage. If sufficient air is not available for proper heater operation, an automatic differential pressure switch in the heater circuit will stop the heater. Both ventilating and combustion air enters the heater inlet. The heating air passes over the heated metal walls of the combustion chamber and is directed to a network of ducting. The air entering the combustion chamber is combined with atomized fuel and, after combustion that heats the metal walls, the exhaust is discharged thru an outlet on the forward upper side of the fuselage. Power for the blower is supplied by the 3-phase No. 2 ac bus thru a circuit breaker, marked CABIN HEATER BLOWER, on the No. 2 power distribution panel. The rest of the system receives its power from the No. 2 dc bus thru a circuit breaker marked CABIN HEATER CONT, on the No. 2 power distribution panel.

2-177. *Heater Function Switch.*

A three-position heater function switch (fig. 2-8 and 2-29) is on the HTG control panel of the overhead switch panel. The switch selects the desired feature of the heating and ventilating system. When the switch is set to BLWR ONLY, the blower forces unheated air into both the cockpit and cabin. Further movement of the heater controls is not required. Selecting HTR ON energizes the various units of the heater once the heater start switch is pressed. The heating and ventilating system is shut down when the switch is set to OFF.

2-178. *Heater Start Switch.*

A spring-loaded heater start switch (fig. 2-8 and 2-29) is below the heater function switch on the heating control panel. When HTR ON is selected and the HTR START button pressed, the heater control circuits are energized. The blower starts and purges the heater combustion chamber of any unburned fuel, while the remainder of the circuit remains inactive because of a 10 to 15 second time-delay relay. After the time-delay relay is energized, the ignition assembly is powered and the master fuel solenoid valve opens, allowing fuel to flow to the heater fuel control unit to complete the start.

2-179. *Temperature Selector.*

The rheostat-type temperature selector is next to the HTR START pushbutton. This switch operates in conjunction with the temperature controller relay in the heater circuit and with a cabin thermostat. One set of contacts on the temperature controller relay closes to complete a circuit to the fuel control solenoid valve. This allows fuel to be delivered to the heater. The second set of contacts on the temperature controller relay closes to complete the circuit to the heater windings in the cabin thermostat. The heater windings heat a column of mercury in the thermostat, causing it to rise. When the mercury column reaches a 34°C contact, the temperature control relay is shunted, causing its contacts to open and interrupt the circuit to the fuel control solenoid valve. This stops heater operation by shutting off the fuel supply to the heater. The circuit to the thermostat heater winding is also interrupted, allowing the winding to cool and the mercury column to contract, thus reenergizing the temperature controller relay. This creates a cycling effect, the rate of which can be varied by increasing or decreasing the resistance between the temperature selector and the thermostat heating winding. Resistance is varied by turning the temperature selector knob. This increase or decrease in resistance directly varies the time the heater is allowed to operate before being automatically cycled.

2-180. *Cockpit Air Knob.*

Two cockpit air knobs (15 and 47, fig. 2-7 and fig. 2-29) are on the lower outboard corner of both the pilot's and the copilot's instrument panels. The knobs are marked PULL FOR COCKPIT AIR. Each knob controls a valve on the heater ducting which regulates the airflow to the cockpit.

2-181. *Air Control Handles.*

Two air control handles (fig. 2-29) are attached to a placard on the right side of the console. The placard is marked AIR CONTROL PULL FOR ON with each handle marked COCKPIT DEFOG OR DEFROST and CABIN AIR. By pulling the DEFOG OR DEFROST handle, heated or ventilating air is directed to the cockpit nose enclosure ducting. The airflow is directed to the transparent portion of the jettisonable doors and nose enclosure providing defrosting as well as additional forward cockpit section heating. When the CABIN AIR handle is pulled, heated or ventilating air flows thru the ducting to the cabin.

2-182. *Cabin Heat Controls.*

Fourteen manually adjustable outlets are provided in the cabin for the comfort of the passengers.

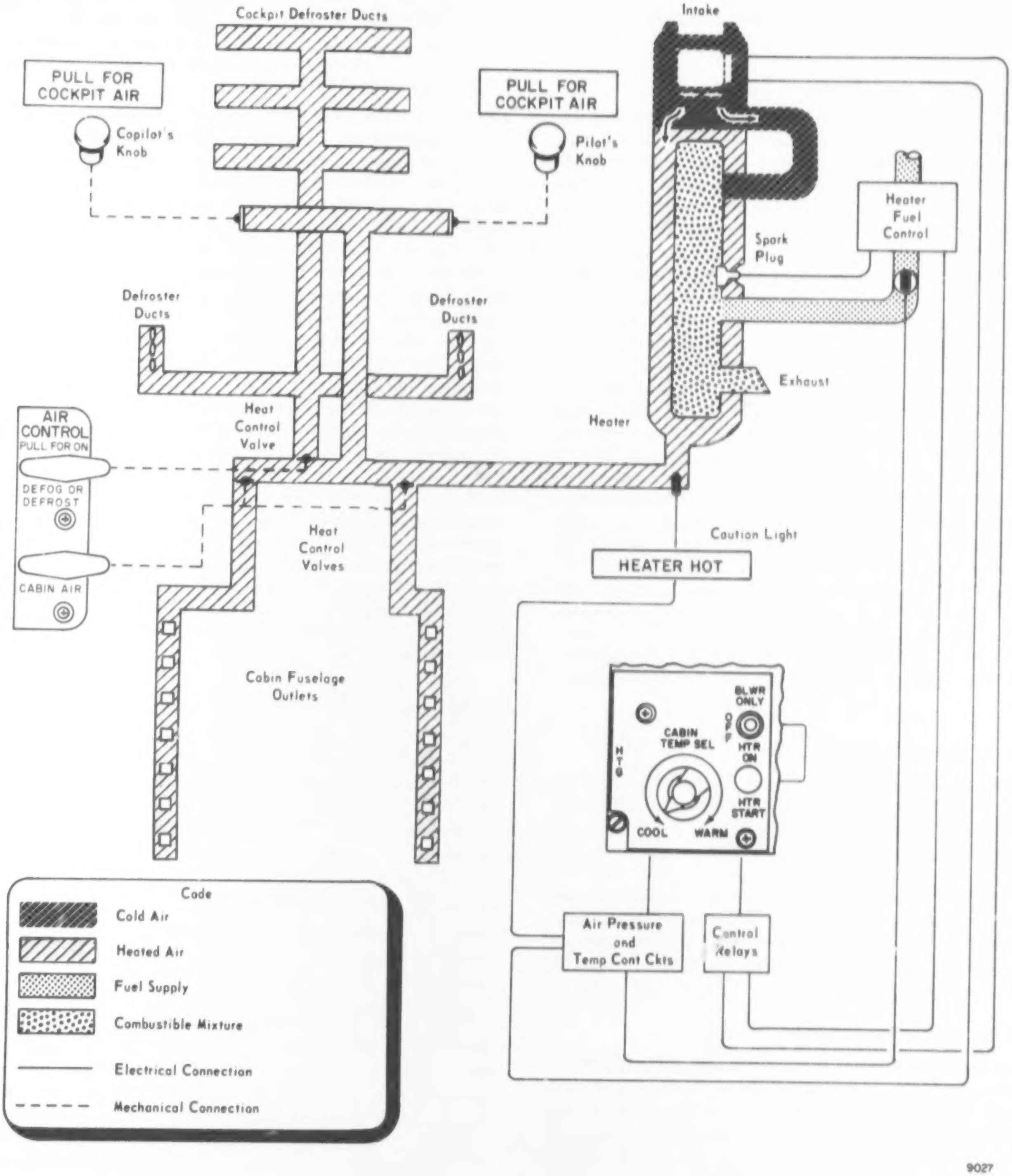

Cockpit Defroster Ducts
Intake
PULL FOR COCKPIT AIR
PULL FOR COCKPIT AIR
Copilot's Knob
Pilot's Knob
Heater Fuel Control
Spark Plug
Defroster Ducts
Defroster Ducts
Exhaust
AIR CONTROL
PULL FOR ON
Heat Control Valve
Heater
DEFOG OR DEFROST
Heat Control Valves
Caution Light
HEATER HOT
CABIN AIR
Cabin Fuselage Outlets
BLWR ONLY
OFF
CABIN TEMP SEL
HTG
HTR ON
HTR START
COOL
WARM
Code
Cold Air
Heated Air
Fuel Supply
Combustible Mixture
Electrical Connection
Mechanical Connection
Air Pressure and Temp Cont Ckts
Control Relays
9027

Figure 2-29. Heating and Ventilating System (Typical)

2-183. Heater Caution Light.

An amber heater caution light, marked HEATER HOT, is on the master caution panel (fig. 2-46). This light indicates failure of the automatic temperature control circuit. If air temperature in the heater rises to 177°C, an overheat switch deenergizes the automatic temperature controller relay, shuts off the heating system, except the blower, and lights the HEATER HOT caution light. The heating system will not operate until the blower has lowered the heater temperature to normal and the heater start button is pressed. Even though the temperature in the combustion chamber has lowered, the HEATER HOT caution light will not go out until the HTR START pushbutton is pressed.

NOTE

Since the HEATER HOT caution light will not go out until the temperature in the combustion chamber is below 177°C, it may take several attempts at restarting the heater before the HEATER HOT caution light goes out.

2-184. Normal Operation — Heating and Ventilating System.

CAUTION

Cycling of the heater blower may disable power steering control.

a. Starting.

(1) Inlet and outlet covers — Remove.

(2) BATT switch — ON.

(3) Apu — Start.

(4) APU GEN switch — ON. RECT OFF caution lights — Check out.

(5) RIGHTSIDE MAIN FUEL PUMPS switches — ON.

CAUTION

Pull out the cockpit air knobs slowly to preclude dirt and debris from being blasted into the air and the pilot's eyes.

(6) Push in the air control knobs.

(7) Heater function switch — As desired. (HTR ON or BLWR ONLY.)

(8) HTR START switch — Press.

NOTE

If the left side of the helicopter is exposed to the sun, the cabin thermostat may be heated to 34°C which is sufficient to prevent starting the heater.

(9) CABIN TEMP SEL — As desired.

b. Heat Distribution.

(1) For maximum cockpit heat proceed as follows:

(a) Pilot's and copilot's cockpit air control knobs — Pull.

(b) DEFOG OR DEFROST handle — Pull.

(c) CABIN AIR handle — Push.

(d) CABIN TEMP SEL — Full clockwise.

(2) For maximum cabin heat proceed as follows:

(a) Pilot's and copilot's air control knobs — Push.

(b) DEFOG OR DEFROST handle — Push.

(c) CABIN AIR handle — Pull.

(d) Cabin adjustable outlets — Full open.

(e) CABIN TEMP SEL — Full clockwise.

c. Stopping.

(1) Heater function switch — OFF.

(2) Wait two minutes before turning generator(s) off.

(3) After the heating and ventilating system has been stopped with the apu generator on, the blower will continue to operate until the temperature within the heater combustion chamber is below 49°C.

2-185 thru 2-187. Deleted.

2-188. Alternate Operation — Heating and Ventilating System.

The following paragraphs describe heating and ventilating system failure modes.

2-189. Vibrator Contact Failure. The heater may be equipped with either a solid-state vibrator or an electromechanical vibrator. The electromechanical vibrators may experience vibrator contact failure, which will result in failure of the heater to operate. Heaters equipped with electromechanical vibrators are identified by a rotary selector switch on the heater junction box. The electromechanical vibrator is equipped with two separate sets of contacts designated NORMAL and RESERVE. Upon failure of the normal contacts, the reserve set may be brought into operation by moving the switch on the junction box to the RESERVE position. The junction box is on the ignition unit next to the heater.

2-190. Heater Overheat Condition.

If the HEATER HOT caution light comes on, proceed as follows:

CAUTION

The heater function switch shall remain ON while performing steps a. thru c.

a. Wait 2 minutes for cooldown.

b. HTR START switch — Press.

c. HEATER HOT caution light — MONITOR. The HEATER HOT caution light will not go out until combustion chamber temperature is below 177°C and the HTR START switch is pressed.

SECTION XI ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEMS

2-191. Electrical Power Supply System.

Alternating current (ac) is the primary source of power to operate the electrical and electronic equipment. Three ac generators, two driven by the aft transmission and one driven by the apu, produce 115/200-volt 3-phase 400-Hz power. The system develops 28-volt dc thru two transformer-rectifiers one each in the forward section of the left and right fuselage pods. Direct current is also supplied by a 24-volt nickel-cadmium battery. On the ground, both 115/200-volt 3-phase ac and 28-volt dc can be supplied by operating the apu or by connecting an ac external power source to the external power receptacles (fig. 2-30). If the apu is running or ac external power is connected, dc power is supplied by the helicopter transformer-rectifiers. If only dc external power is supplied, ac power is not available on the helicopter. Circuits are protected by circuit breakers (fig. 2-31 and 2-32). The electrical load is divided between the two ac generators (fig. 2- 33). Should one generator fail, the other will automatically take over the entire load. When the apu is running, its single generator powers the entire load.

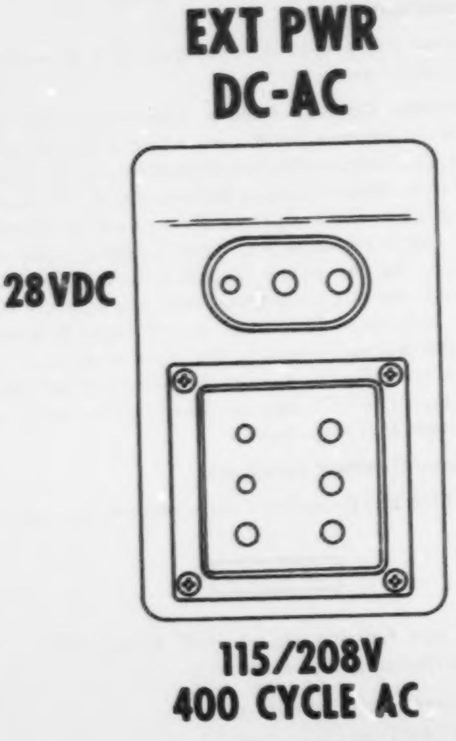


Figure 2-30. External Power Receptacles

2-192. AC System.

The ac system (fig. 2-34) supplies 115/200-volt three-phase 400-Hz power from No. 1 ac generator to No. 1 three-phase ac bus and from No. 2 ac generator to the No. 2 three-phase ac bus. The ac equipment is powered by these buses. Some of the equipment is operated by 115-volt single-phase ac and some equipment by 26-volt ac power supplied thru transformers.The ac system is protected from overvoltage, undervoltage, and underfrequency conditions by generator control units. The generators will be disconnected from the ac buses any time the frequency drops below 325 to 335 Hz for more than 3 to 7 seconds. These frequencies correspond 82 to 85 percent rotor rpm. The ac power distribution system has four power sources (generators), a contactor control circuit, an ac power transfer circuit, and two ac buses. The No. 1 and No. 2 generator power sources are two main generators driven directly by the aft transmission. The apu generator is driven directly by the apu. The external power source is an ac power supply connected to the helicopter. When rotor speed increases above about 91 percent, No. 1 and No. 2 generators feed their respective buses. If No. 1 or No. 2 generator fails (or are shut down), the failed generator is isolated from its bus and the operating generator feeds both buses. When No. 1 or No. 2 or both generators are operating, apu generator and external power are blocked from the ac buses. When the apu is operating and the main generators are shut down (rotors turning below about 84%) or switched off, the apu generator feeds both buses. When the apu generator is operating, external power is blocked from the ac buses. When external power is applied to the helicopter (apu and rotors stopped), the external power source feeds both buses. The generator control panel also provides generator feeder fault protection. If a fault occurs between the feeder and the airframe, the control panel will disable the generators. This prevents structural damage to the airframe when a ground fault occurs. The PMG (permanent magnet generator) section within the generator is used to power the main contactors (relays) in the distribution system. A pickoff coil within the PMG provides an rpm signal for the rotor tachometer indicators. This tachometer signal is available whenever the rotors are turning.

2-193. *Generator Control Switches.* Three three-position switches to control the ac generators are on the electrical power panel (fig. 2-33) of the overhead switch panel. The switches are labeled GEN, NO. 1, NO. 2 and APU. The switch positions are ON, OFF RESET, and TEST. When the switches are ON, the respective main relay operates, which energizes and connects the generator to the buses. At OFF RESET, the generator is deenergized and disconnected from the bus. This position is also used to reset a generator. The TEST position is provided to

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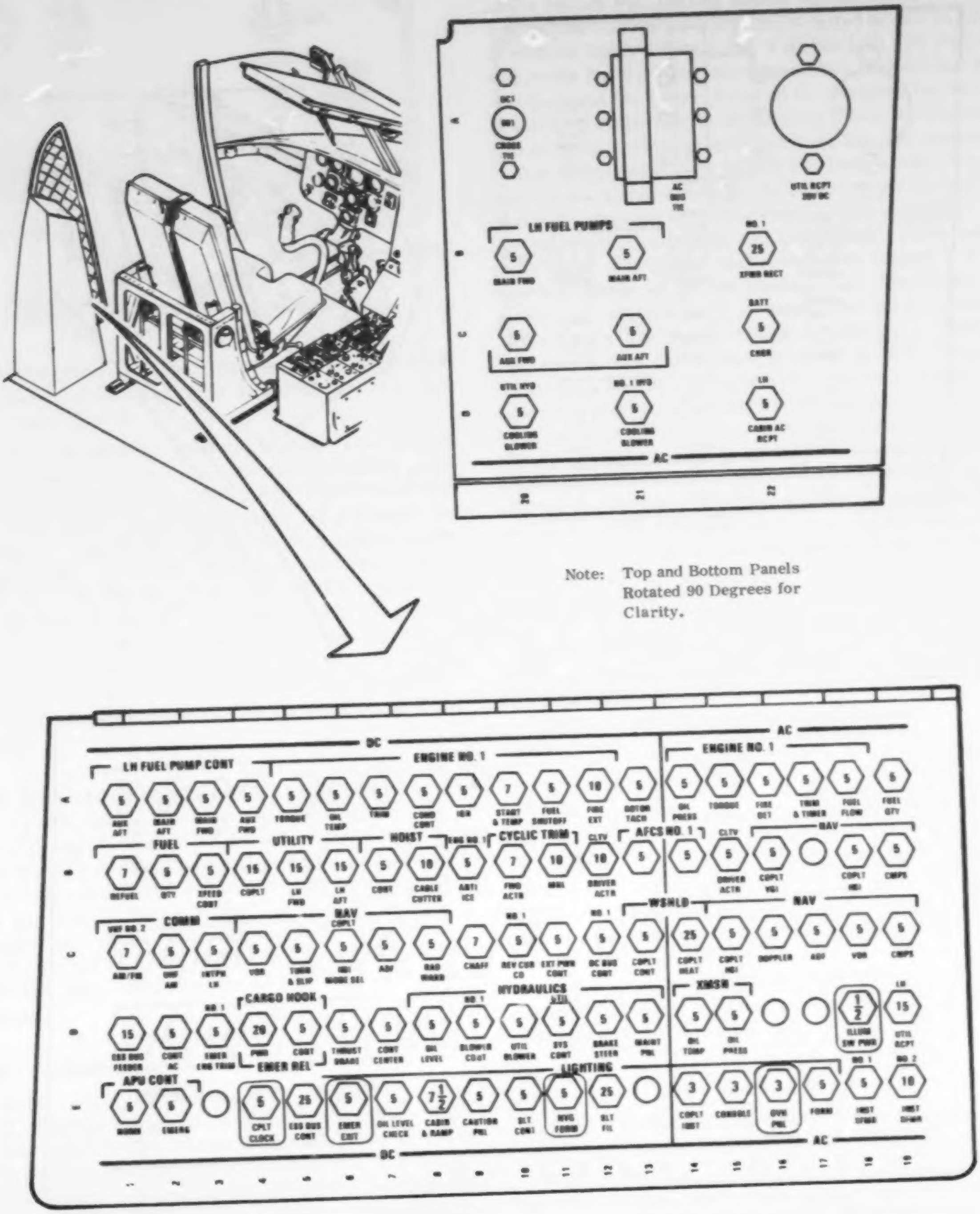
OC1
BUS
CROSS
TIE
AC
BUS
TIE
UTIL RCPT
28V DC
LH FUEL PUMPS
MAIN FWD
MAIN AFT
NO. 1
XFMR RECT
AUX FWD
AUX AFT
BATT
CHGR
UTIL HYD
NO. 1 HYD
COOLING
BLOWER
LH
CABIN AC
RCPT
AC
20
21
22
DC
AC
LH FUEL PUMP CONT
ENGINE NO. 1
AUX AFT
MAIN AFT
MAIN FWD
AUX FWD
TORQUE
OIL TEMP
TRIM
COND CONT
IGN
START & TEMP
FUEL SHUTOFF
FIRE EXT
ROTOR TACH
OIL PRESS
FIRE DET
TRIM & TIMER
FUEL FLOW
FUEL QTY
FUEL
UTILITY
HOIST
ENG NO. 1
CYCLIC TRIM
CLTV
AFCS NO. 1
NAV
REFUEL
QTY
SPEED CONT
COPLT
LH FWD
LH AFT
CONT
CABLE CUTTER
ANTI ICE
FWD ACTR
MAL
DRIVER ACTR
COPLT VGI
COPLT HSI
CMPS
COMM
VHF NO. 2
WSHLD
AM/FM
UHF AM
INTPH LH
VOR
TURN & SLIP
HSI MODE SEL
ADF
RAD WARN
CHAFF
REV CUR CO
EXT PWR CONT
DC BUS CONT
COPLT CONT
COPLT HEAT
DOPPLER
CARGO HOOK
HYDRAULICS
XMSN
ESS BUS FEEDER
CONT AC
EMER ENG TRIM
FWD
THRUST BRAKE
CONT CENTER
OIL LEVEL
BLOWER COOT
UTIL BLOWER
SYS CONT
BRAKE STEER
MAINT PNL
ILLUM SW PWR
UTIL RCPT
EMER REL
APU CONT
LIGHTING
NORM
EMERG
CPLT CLOCK
ESS BUS CONT
EMER EXIT
OIL LEVEL CHECK
CABIN & RAMP
CAUTION PNL
SLT CONT
NVG FORM
SLT FIL
COPLT INST
CONSOLE
OVH PNL
FORM
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INST DIMR
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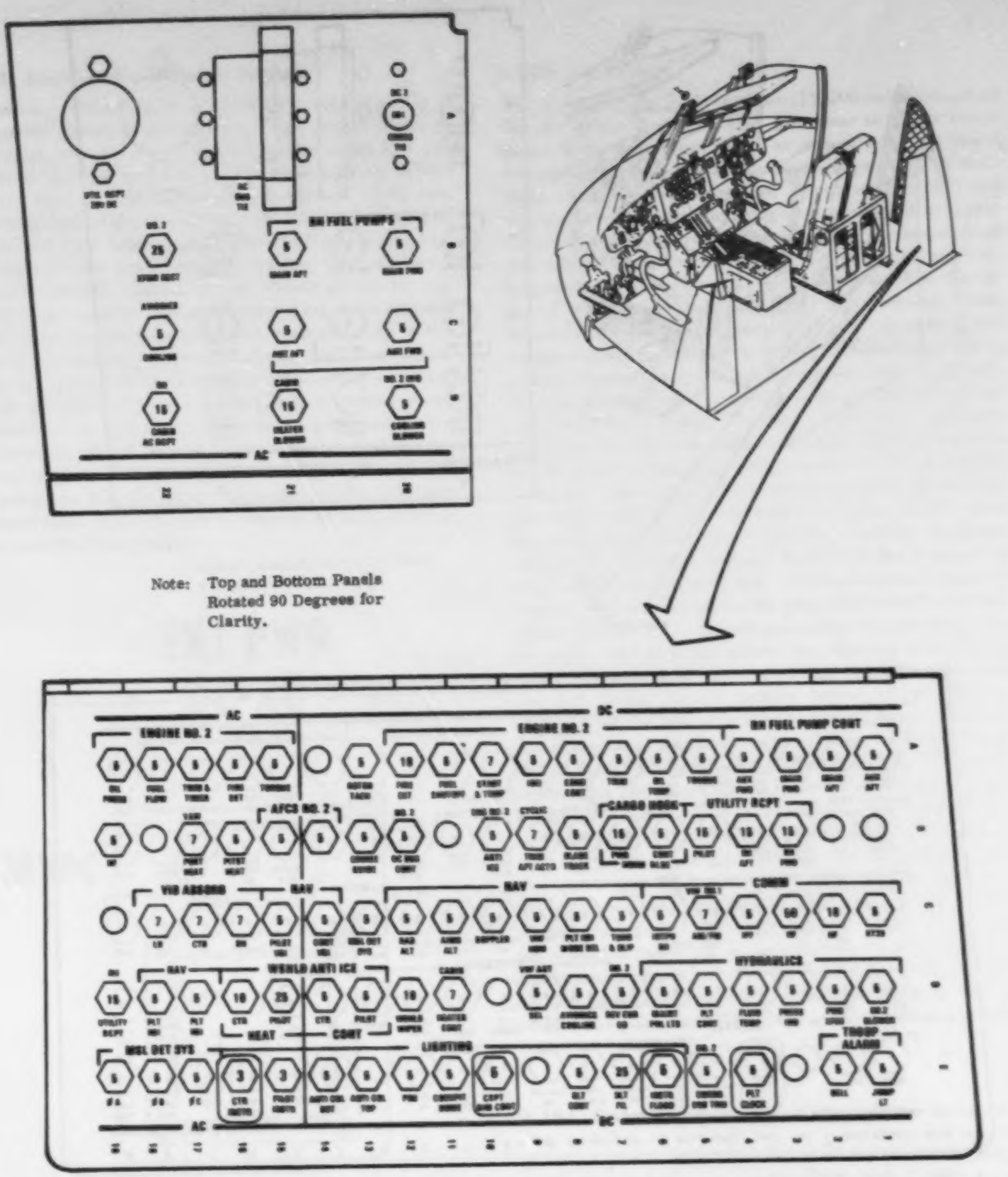
Note: Top and Bottom Panels Rotated 90 Degrees for Clarity.

9028

Figure 2-31. No. 1 Power Distribution Panel (Typical)


FUEL PUMPS
AC
ENGINE NO. 2
AFCS NO. 2
DC
CARGO HOOK
UTILITY RCPT
VIB ABSORB
NAV
COMM
WSHLD ANTI ICE
HEAT
CONT
HYDRAULICS
MSL DET SYS
LIGHTING
TROOP ALARM
9029

Note: Top and Bottom Panels Rotated 90 Degrees for Clarity.

Figure 2-32. No. 2 Power Distribution Panel (Typical)

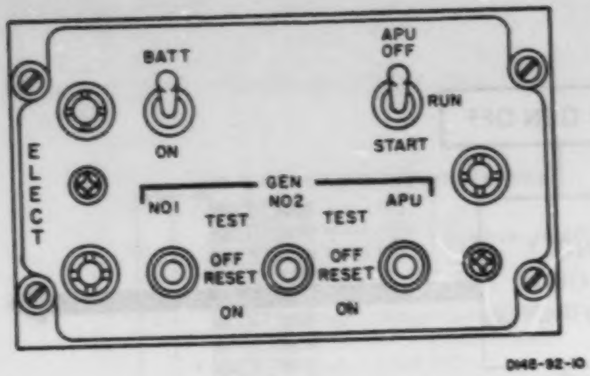


Figure 2-33. Electrical Power Panel

allow the generator to be energized but disconnected from the bus to determine whether the ac produced is of proper frequency and voltage.

2-194. AC Generator Caution Lights. Two amber generator caution lights are on the master caution panel (fig. 2-46). The lights are marked NO. 1 GEN OFF and NO. 2 GEN OFF. These lights come on whenever the generators are inoperative. The lights are controlled by the main generator contactors when the generator control switches are in either the ON or OFF RESET position. In the TEST position, the lights are controlled by the generator control switch and will go out if generator output is the proper frequency and voltage. Current to operate the lights is supplied from the 28- volt dc essential bus thru a CAUTION PNL circuit breaker on the No. 1 power distribution panel.

2-195. External Power Caution Light. An external power caution light is on the master caution panel (fig. 2-46) on the console. Marked EXT PWR, this light comes on and remains on whenever external power is connected. The light is controlled by the ac external power contactor and the dc power relay. The light goes out when the generators are supplying current to the buses. Power to operate the light is supplied from the 28-volt dc essential bus thru the CAUTION PNL circuit breaker on No. 1 power distribution panel.

2-196. DC System

The direct current (dc) power supply (fig. 2-35) system supplies 28-volt dc from No. 1 transformer-rectifier to No. 1 dc bus and from No. 2 transformer-rectifier to No. 2 dc bus. Transformer rectifiers (TR) convert 208 VAC power to 28 vdc power for use in the DC distribution system. Cooling air for the TR is obtained from within the cabin. The air inlets are located at sta 176 on the left and right side of the cabin behind the troop seats. If the inlets are blocked the TR will overheat. A cross-tie relay is between No. 1 and No. 2 dc buses. If either transformer-rectifier fails, the respective transformer-rectifier failure relay operates and the bus-tie relay closes automatically to connect the unpowered bus to the operating transformer-rectifier. In addition to No. 1 and No. 2 dc buses, the dc system includes an essential bus, a switched battery bus, and a battery bus. During normal operation, the essential bus and the switched battery are energized by No. 1 dc bus. If both dc buses fail or if No. 1 dc bus fails and does not crosstie to No. 2 dc bus, the essential bus, the switched battery bus, and the battery bus will be energized by the battery as long as the battery switch is on. These buses provide power to emergency, ground maintenance, and communications components. The battery bus and switched battery bus are energized as long as the battery is connected. The hydraulic reservoir level indicators and the emergency apu control circuits and cabin and maintenance lights are on these buses. The 24-volt nickel-cadmium battery is in the forward section of the left fuselage pod. The battery capacity is 11 ampere-hours. A battery charger is connected to the battery. The battery charger receives power from No. 1 ac bus, rectifies the ac and applies the dc to the battery to maintain a charge on the battery. Sensors in the battery charger detect battery or battery charger overtemperature, short or open circuits or cell imbalance. If any of these conditions occur, the battery charger will stop functioning and turn on the BATT SYS MAL caution light on the master caution panel. External dc power is supplied to the dc buses of the helicopter by connecting the external dc power source to the dc external power receptacle (fig. 2-30). Application of external power operates the dc external power relay which connects the power source to No. 1 dc bus. No. 2 dc bus is energized when the bus tie relay operates. If the polarity of the external power is reversed, a blocking diode in the circuit prevents the external power relay from closing.

2-197. Battery Switch. A two-position battery switch is on the electrical power control panel of the overhead panel. (See fig. 2-33.) The battery switch positions are ON and OFF. When the switch is at ON, the essential, switched battery, and battery buses are energized. Regardless of the battery switch position, the switched battery and battery buses are powered directly by the battery. To prevent extensive discharging of the battery while making extended ground checks of equipment, use an external electrical power source or operate the apu.

2-198. Transformer-Rectifier Caution Lights. Two amber transformer-rectifier caution lights, on the master caution panel (fig. 2-46), are marked NO. 1 RECT OFF and NO. 2 RECT OFF. These caution lights are controlled by the reverse-current cutouts. Whenever one of the transformer-rectifiers fails, either thru a fault in the transformer-rectifier or a bus fault, the respective caution light comes on. Current to operate the lights is supplied by the 28-volt dc essential bus thru the CAUTION PNL circuit breaker on No. 1 power distribution panel.

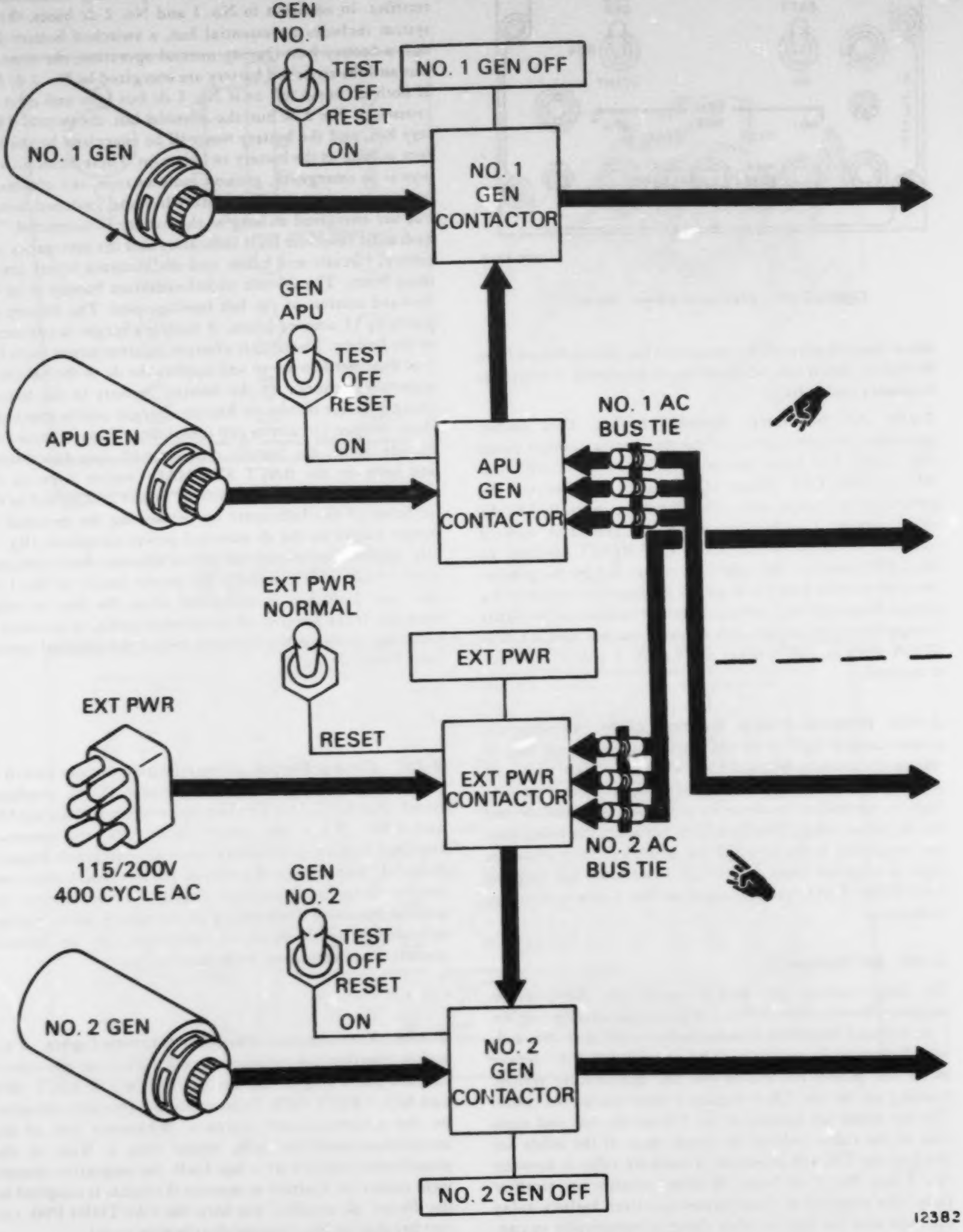

GEN
NO. 1
TEST
OFF
RESET
ON
NO. 1 GEN OFF
NO. 1 GEN
NO. 1
GEN
CONTACTOR
GEN
APU
TEST
OFF
RESET
ON
APU GEN
APU
GEN
CONTACTOR
NO. 1 AC
BUS TIE
EXT PWR
NORMAL
EXT PWR
RESET
EXT PWR
EXT PWR
CONTACTOR
115/200V
400 CYCLE AC
NO. 2 AC
BUS TIE
GEN
NO. 2
TEST
OFF
RESET
ON
NO. 2 GEN
NO. 2
GEN
CONTACTOR
NO. 2 GEN OFF
12382

Figure 2-34. AC Power Supply (Typical) (Sheet 1 of 2)

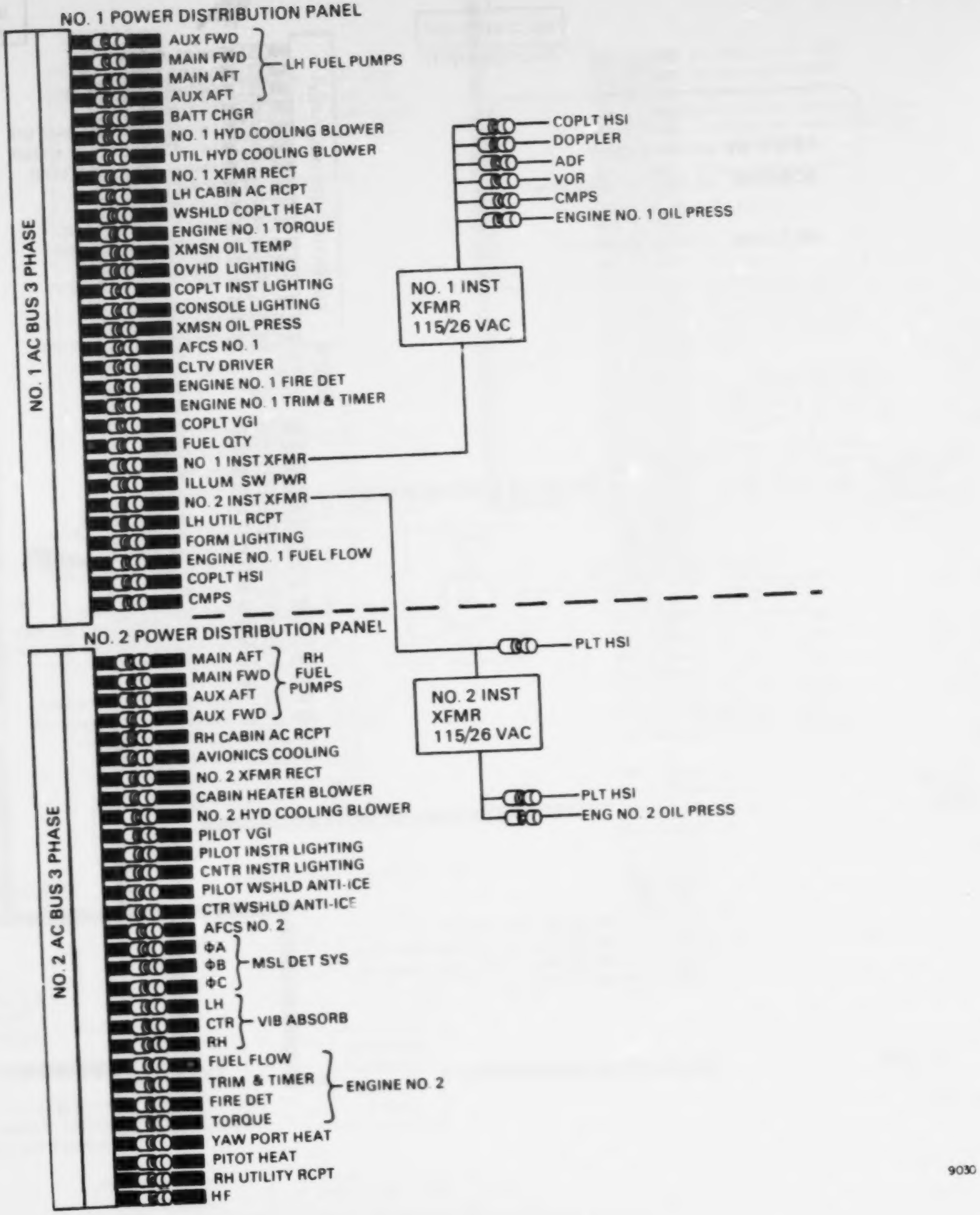

NO. 1 POWER DISTRIBUTION PANEL
NO. 1 AC BUS 3 PHASE
AUX FWD
MAIN FWD
MAIN AFT
AUX AFT
LH FUEL PUMPS
BATT CHGR
NO. 1 HYD COOLING BLOWER
UTIL HYD COOLING BLOWER
NO. 1 XFMR RECT
LH CABIN AC RCPT
WSHLD COPLT HEAT
ENGINE NO. 1 TORQUE
XMSN OIL TEMP
OVHD LIGHTING
COPLT INST LIGHTING
CONSOLE LIGHTING
XMSN OIL PRESS
AFCS NO. 1
CLTV DRIVER
ENGINE NO. 1 FIRE DET
ENGINE NO. 1 TRIM & TIMER
COPLT VGI
FUEL QTY
NO 1 INST XFMR
ILLUM SW PWR
NO. 2 INST XFMR
LH UTIL RCPT
FORM LIGHTING
ENGINE NO. 1 FUEL FLOW
COPLT HSI
CMPS
COPLT HSI
DOPPLER
ADF
VOR
CMPS
ENGINE NO. 1 OIL PRESS
NO. 1 INST XFMR 115/26 VAC
NO. 2 POWER DISTRIBUTION PANEL
NO. 2 AC BUS 3 PHASE
MAIN AFT
MAIN FWD
AUX AFT
AUX FWD
RH FUEL PUMPS
RH CABIN AC RCPT
AVIONICS COOLING
NO. 2 XFMR RECT
CABIN HEATER BLOWER
NO. 2 HYD COOLING BLOWER
PILOT VGI
PILOT INSTR LIGHTING
CNTR INSTR LIGHTING
PILOT WSHLD ANTI-ICE
CTR WSHLD ANTI-ICE
AFCS NO. 2
ΦA
ΦB
ΦC
MSL DET SYS
LH
CTR
RH
VIB ABSORB
FUEL FLOW
TRIM & TIMER
FIRE DET
TORQUE
ENGINE NO. 2
YAW PORT HEAT
PITOT HEAT
RH UTILITY RCPT
HF
PLT HSI
NO. 2 INST XFMR 115/26 VAC
PLT HSI
ENG NO. 2 OIL PRESS
9030

Figure 2-34. AC Power Supply (Typical) (Sheet 2 of 2)

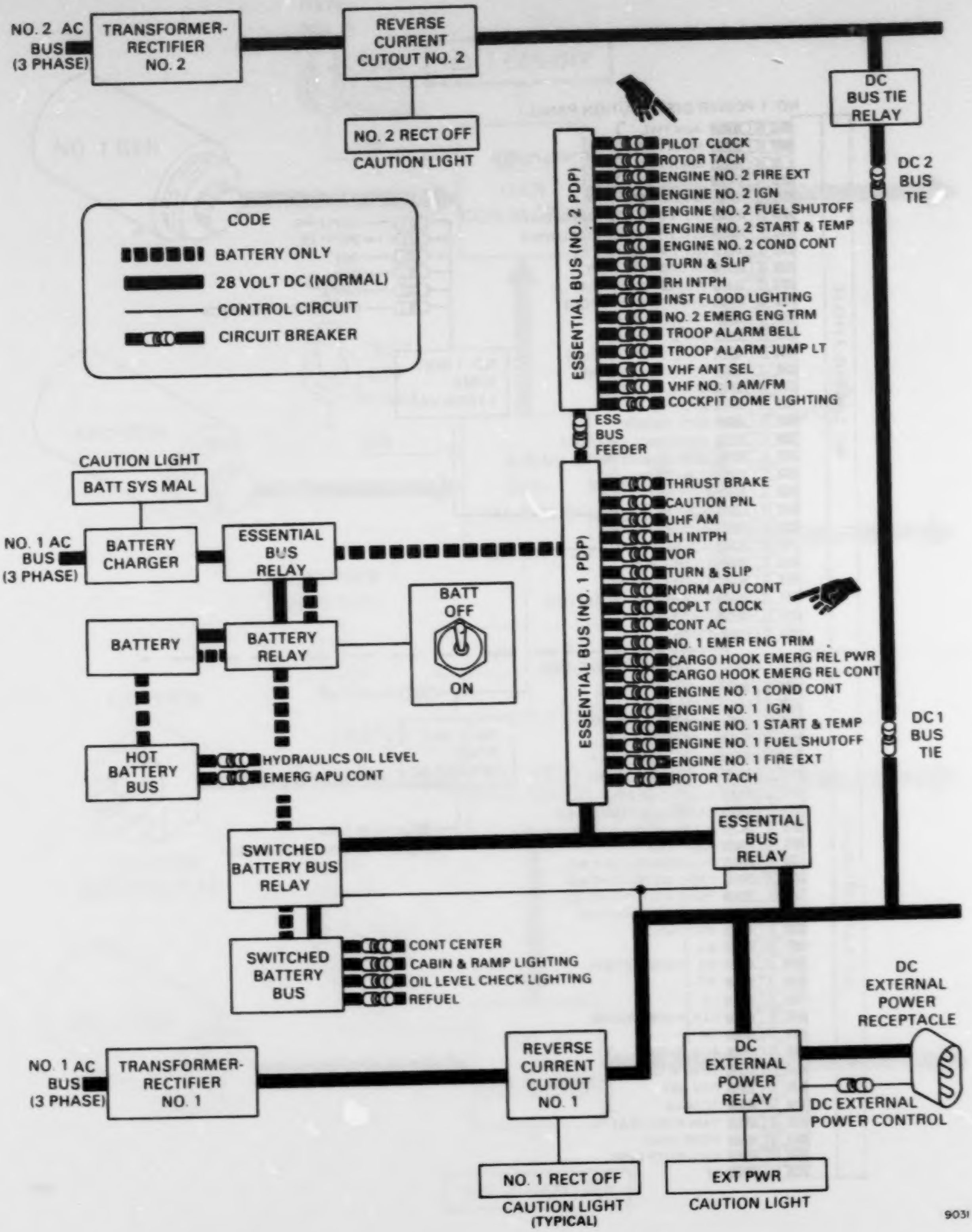

NO. 2 AC BUS (3 PHASE)
TRANSFORMER-RECTIFIER NO. 2
REVERSE CURRENT CUTOUT NO. 2
NO. 2 RECT OFF
CAUTION LIGHT
DC BUS TIE RELAY
DC 2 BUS TIE
CODE
BATTERY ONLY
28 VOLT DC (NORMAL)
CONTROL CIRCUIT
CIRCUIT BREAKER
ESSENTIAL BUS (NO. 2 PDP)
PILOT CLOCK
ROTOR TACH
ENGINE NO. 2 FIRE EXT
ENGINE NO. 2 IGN
ENGINE NO. 2 FUEL SHUTOFF
ENGINE NO. 2 START & TEMP
ENGINE NO. 2 COND CONT
TURN & SLIP
RH INTPH
INST FLOOD LIGHTING
NO. 2 EMERG ENG TRM
TROOP ALARM BELL
TROOP ALARM JUMP LT
VHF ANT SEL
VHF NO. 1 AM/FM
COCKPIT DOME LIGHTING
ESS BUS FEEDER
CAUTION LIGHT
BATT SYS MAL
NO. 1 AC BUS (3 PHASE)
BATTERY CHARGER
ESSENTIAL BUS RELAY
BATTERY
BATTERY RELAY
BATT OFF
ON
HOT BATTERY BUS
HYDRAULICS OIL LEVEL
EMERG APU CONT
ESSENTIAL BUS (NO. 1 PDP)
THRUST BRAKE
CAUTION PNL
UHF AM
LH INTPH
VOR
TURN & SLIP
NORM APU CONT
COPLT CLOCK
CONT AC
NO. 1 EMER ENG TRIM
CARGO HOOK EMERG REL PWR
CARGO HOOK EMERG REL CONT
ENGINE NO. 1 COND CONT
ENGINE NO. 1 IGN
ENGINE NO. 1 START & TEMP
ENGINE NO. 1 FUEL SHUTOFF
ENGINE NO. 1 FIRE EXT
ROTOR TACH
DC 1 BUS TIE
ESSENTIAL BUS RELAY
SWITCHED BATTERY BUS RELAY
SWITCHED BATTERY BUS
CONT CENTER
CABIN & RAMP LIGHTING
OIL LEVEL CHECK LIGHTING
REFUEL
DC EXTERNAL POWER RECEPTACLE
NO. 1 AC BUS (3 PHASE)
TRANSFORMER-RECTIFIER NO. 1
REVERSE CURRENT CUTOUT NO. 1
DC EXTERNAL POWER RELAY
DC EXTERNAL POWER CONTROL
NO. 1 RECT OFF
CAUTION LIGHT (TYPICAL)
EXT PWR
CAUTION LIGHT
9031

Figure 2-35. DC Power Supply (Typical) (Sheet 1 of 2)

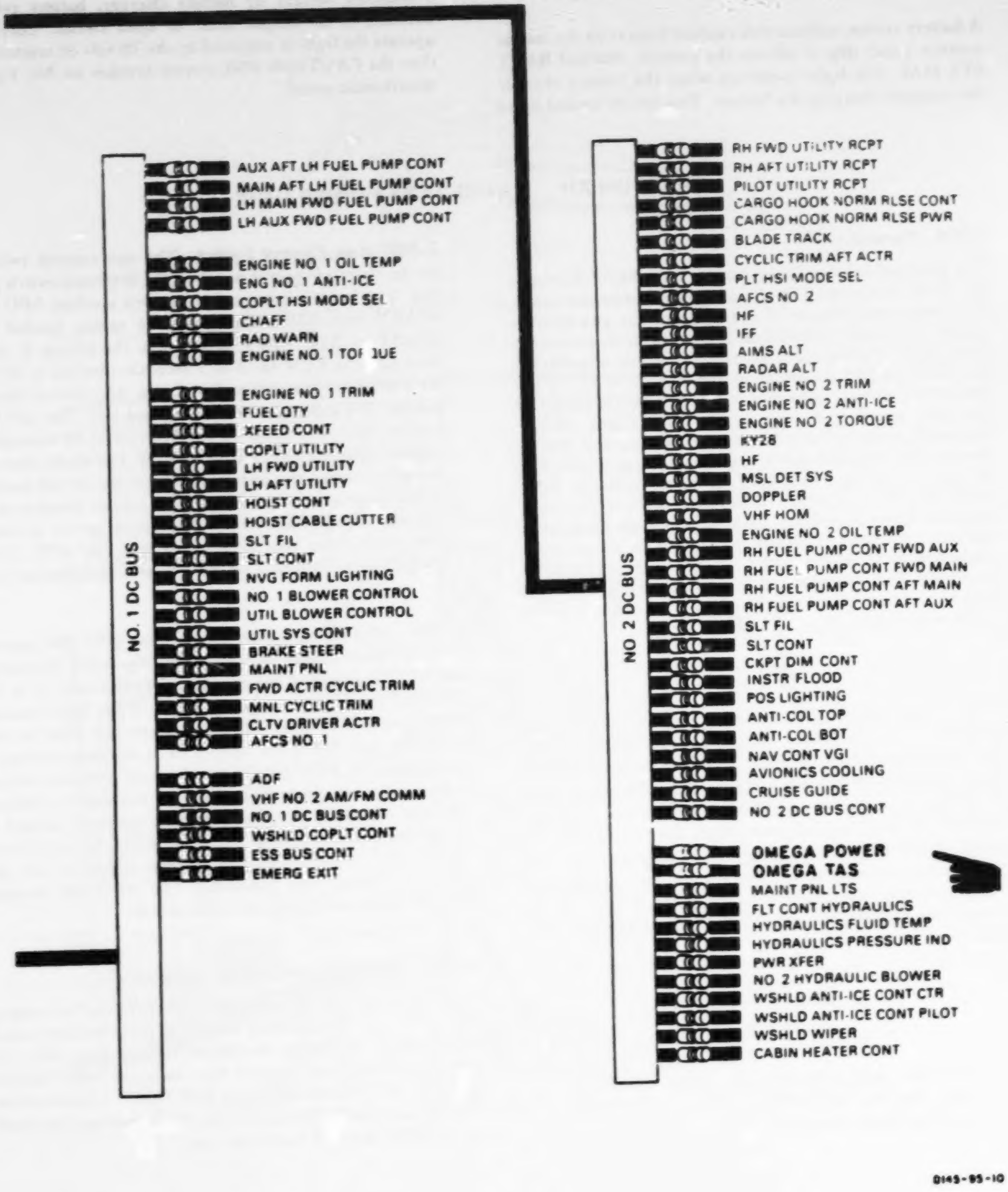

NO. 1 DC BUS
AUX AFT LH FUEL PUMP CONT
MAIN AFT LH FUEL PUMP CONT
LH MAIN FWD FUEL PUMP CONT
LH AUX FWD FUEL PUMP CONT
ENGINE NO 1 OIL TEMP
ENG NO 1 ANTI-ICE
COPLT HSI MODE SEL
CHAFF
RAD WARN
ENGINE NO. 1 TORQUE
ENGINE NO 1 TRIM
FUEL QTY
XFEED CONT
COPLT UTILITY
LH FWD UTILITY
LH AFT UTILITY
HOIST CONT
HOIST CABLE CUTTER
SLT FIL
SLT CONT
NVG FORM LIGHTING
NO 1 BLOWER CONTROL
UTIL BLOWER CONTROL
UTIL SYS CONT
BRAKE STEER
MAINT PNL
FWD ACTR CYCLIC TRIM
MNL CYCLIC TRIM
CLTV DRIVER ACTR
AFCS NO 1
ADF
VHF NO. 2 AM/FM COMM
NO. 1 DC BUS CONT
WSHLD COPLT CONT
ESS BUS CONT
EMERG EXIT
NO 2 DC BUS
RH FWD UTILITY RCPT
RH AFT UTILITY RCPT
PILOT UTILITY RCPT
CARGO HOOK NORM RLSE CONT
CARGO HOOK NORM RLSE PWR
BLADE TRACK
CYCLIC TRIM AFT ACTR
PLT HSI MODE SEL
AFCS NO 2
HF
IFF
AIMS ALT
RADAR ALT
ENGINE NO 2 TRIM
ENGINE NO 2 ANTI-ICE
ENGINE NO 2 TORQUE
KY28
HF
MSL DET SYS
DOPPLER
VHF HOM
ENGINE NO 2 OIL TEMP
RH FUEL PUMP CONT FWD AUX
RH FUEL PUMP CONT FWD MAIN
RH FUEL PUMP CONT AFT MAIN
RH FUEL PUMP CONT AFT AUX
SLT FIL
SLT CONT
CKPT DIM CONT
INSTR FLOOD
POS LIGHTING
ANTI-COL TOP
ANTI-COL BOT
NAV CONT VGI
AVIONICS COOLING
CRUISE GUIDE
NO 2 DC BUS CONT
OMEGA POWER
OMEGA TAS
MAINT PNL LTS
FLT CONT HYDRAULICS
HYDRAULICS FLUID TEMP
HYDRAULICS PRESSURE IND
PWR XFER
NO 2 HYDRAULIC BLOWER
WSHLD ANTI-ICE CONT CTR
WSHLD ANTI-ICE CONT PILOT
WSHLD WIPER
CABIN HEATER CONT
0145-95-10

Figure 2-35. DC Power Supply (Sheet 2 of 2)

2-199. *Battery System Malfunction Caution Light.*

A battery system malfunction caution light is on the master caution panel (fig. 2-46) on the console. Marked BATT SYS MAL, this light comes on when the battery charger has stopped charging the battery. This can be caused by an overheated battery or battery charger, battery cell imbalance, or an output short or open circuit. Current to operate the light is supplied by the 28-volt dc essential bus thru the CAUTION PNL circuit breaker on No. 1 power distribution panel.

SECTION XII AUXILIARY POWER UNIT

2-200. General.

The gas turbine auxiliary power unit T62-T-2B (apu) (fig. 2-36) is mounted in the aft cabin above the ramp. The basic components of the apu are the gas turbine engine, hydraulic motor-pump, fuel control, accessory drive, and ac generator. An apu electronic sequencing unit (ESU) which monitors apu operation is on the left side of the cabin above the ramp. The motor-pump on the apu pressurizes the utility and flight control hydraulic systems for main engine starting and ground checks. The apu also drives an ac generator which supplies power to No. 1 and No. 2 electrical systems. Refer to Section VI for further information on the hydraulic systems. Refer to Section XI for further information on electrical systems. The apu oil supply is integral and contained within the sump of the accessory drive assembly. The apu receives fuel from the left main fuel tank thru a booster pump, a manual fuel shutoff valve, and a solenoid valve.

2-201. *Apu Control Box Unit.* The control box is mounted on the left side of the cabin above the ramp. The unit monitors apu starting and operation. It monitors apu speed and exhaust gas temperature. It continuously compares these parameters with limits programmed into control box circuits. If a limit is exceeded, the control box will automatically shut down the apu. Four magnetic built-in-test-equipment (bite) indicators are on the control box. These indicators are either black or white. A label on the control box explains the various bite indications and their meaning.

NOTE

The bite indicators indicate engine condition only. They will not indicate a defective hydraulic motor-pump or generator.

2-202. *Apu Control Switch.* The apu control switch is on the electrical power panel on the overhead switch panel (fig. 2-8) It is a three-position switch marked APU OFF, START, and RUN. The switch is spring loaded from START to RUN. To start the apu, the switch is moved from OFF to RUN for 3 to 5 seconds, then set to START for 2 seconds, then released to RUN. Apu start is then automatic and controlled by the control box. The APU ON caution light will come on in about 10 to 12 seconds. To stop the apu, the switch is set to OFF. Normally, electrical power to control apu operation is from the 28-volt essential dc bus thru the APU CONT NORM circuit breaker on No. 1 power distribution panel. Emergency power to control the apu is from the battery bus thru the APU CONT EMERG circuit breaker on No. 1 power distribution panel.

2-203. *APU ON Caution Light.* The APU ON caution light is on the master caution panel (fig. 2-46). Normally, the APU is intended for ground operation only. It is not intended for operation during flight. If the light remains illuminated following take-off, it alerts the pilot to shut down the apu. When the light is on, it indicates the apu is up to speed, exhaust gas temperature, oil pressure, and oil temperature are normal. It does not necessarily indicate that apu hydraulic pump or generator output is normal. If the rotors are not turning, check the UTIL HYD SYS and RECT OFF caution lights to evaluate output of the apu hydraulic pump and generator. The APU ON caution light is controlled by the apu control box.

2-204. *APU Manual Fuel Shutoff Valve.*

A manual fuel shutoff valve (fig. 2-37) is in the fuel supply line to the apu. It is located inside the aft cabin above and to the left of the ramp interphone station. The valve can also be reached from outside thru an access door labeled ACCESS APU EMERG FLUID SHUTOFF. A knob on the valve is marked OPEN AND CLOSED; moving this knob to CLOSED shuts off fuel to the apu.

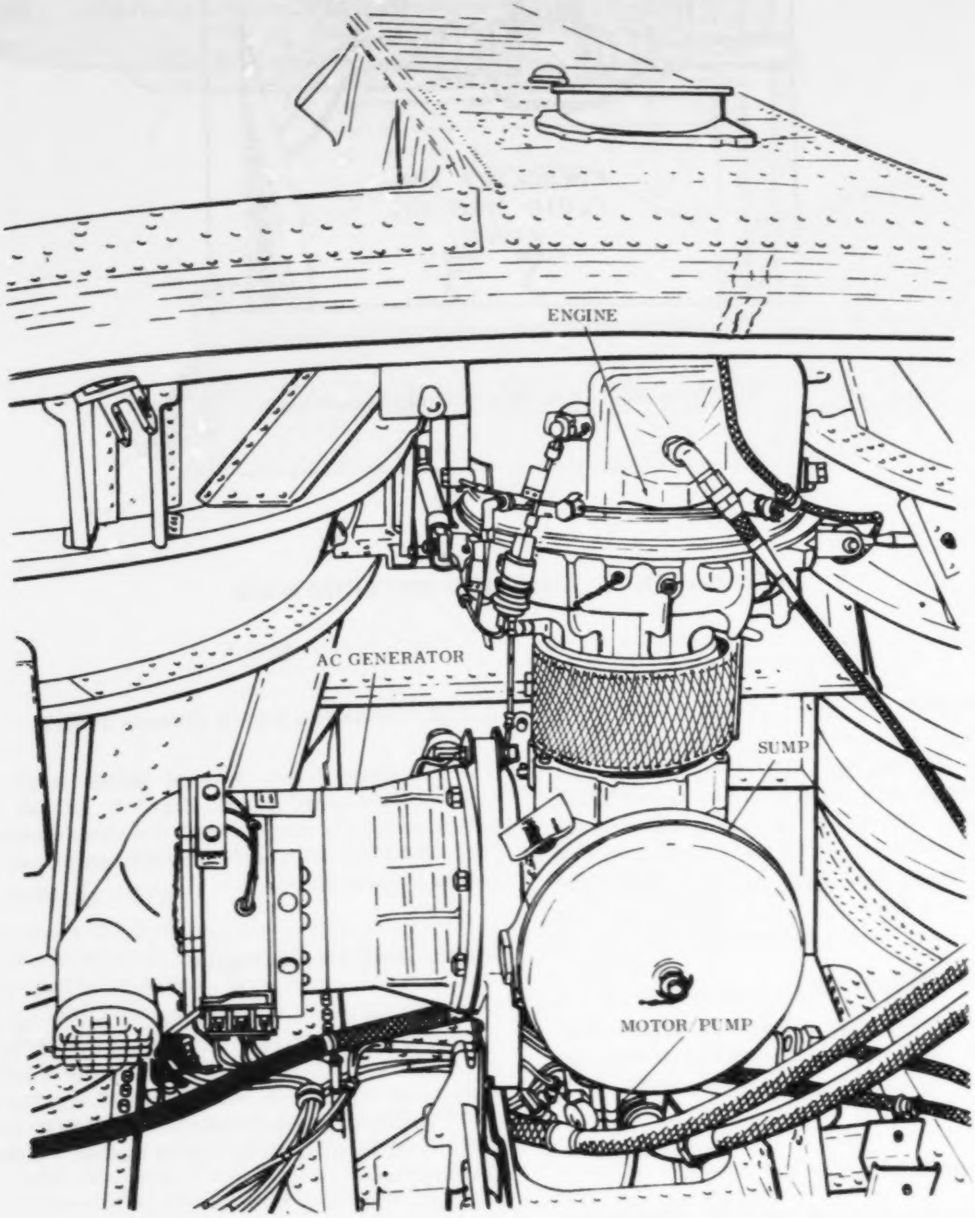

ENGINE
AC GENERATOR
SUMP
MOTOR/PUMP
D145-96-10

Figure 2-36. Auxiliary Power Unit

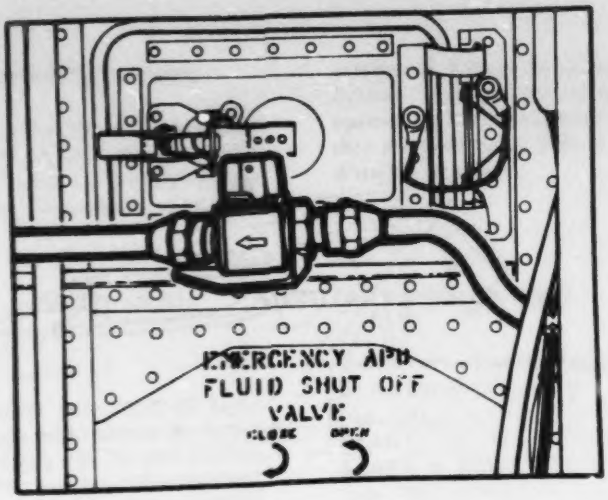


Figure 2-37. Apu Manual Fuel Shutoff Valve

SECTION XIII LIGHTING (INTERIM NVG)

2-205. Position Lights.

Three position lights (1, 4 and 6, figure 2-38) are installed on the helicopter. On the right side of the fuselage is a green light (1); on the left, red (6); and on the aft pylon, white (4). Power for the position lights is supplied by the 28-volt No. 2 dc bus thru a circuit breaker marked POS on the LIGHTING section of the No. 2 power distribution panel.

2-206. Position Lights Switch.

A three-position toggle switch on the left LTG control panel (fig. 2-8) of the overhead switch panel controls the position lights. The switch is marked POSITION LIGHTS DIM-BRT-OFF.

2-207. Formation Lights.

Five electroluminescent panels (2 and 5, fig. 2-38) on top of the fuselage, increase the night formation capability of the helicopter. Three panels, which form an equilateral triangle, are aft of the forward pylon. Two panels are on the aft pylon aft of the anticollision light. The five panels are controlled by a switch on the overhead switch panel. Power to operate and control the formation lights system is supplied by the 115-volt No. 1 ac bus thru the FORM circuit breaker on the LIGHTING section of the No. 1 power distribution panel.

2-208. Formation Lights Control Switch.

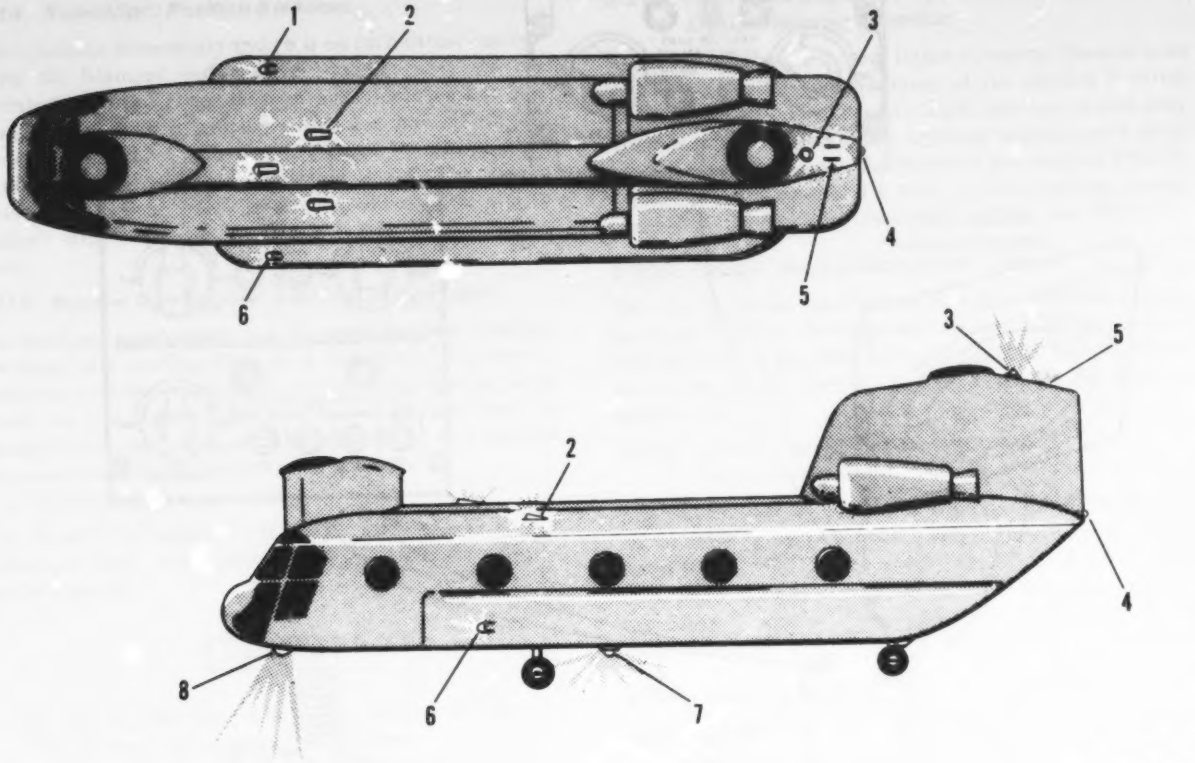
The formation lights control switch is on the left LIGHTING control panel (fig. 2-8) of the overhead switch panel. The rotary switch has three positions: OFF, DIM, and BRT. When switch is OFF, the formation lights system is deenergized.

2-209. Anticollision Lights.

Two red strobe anticollision lights (3 and 7, fig. 2-38) are on the helicopter. One is on top of the aft pylon; the other is on the fuselage underside. Power to operate the anticollision lights is supplied by the 28-volt No. 2 dc bus thru two circuit breakers labeled ANTI-COL TOP and BOT on the LIGHTING section of the No. 2 power distribution panel.

2-210. Anticollision Light Switches.

Two toggle switches are on the right lighting control panel (fig. 2-8) of the overhead switch panel. The two-position switches are marked ANTI-COLL LTS TOP and BOTTOM. Each switch has ON and OFF positions. When the anticollision light switch is ON, the lights are energized. When the switch is moved to OFF the anticollision lights are deenergized.



1. Right position light (Green)	5. Formation lights (2)
2. Formation lights (3)	6. Left position light (Red)
3. Top anticollision light	7. Bottom anticollision light
4. Position light (White)	8. Landing-search lights (2)

Figure 2-38. Exterior Lights

2-211. Landing searchlights.

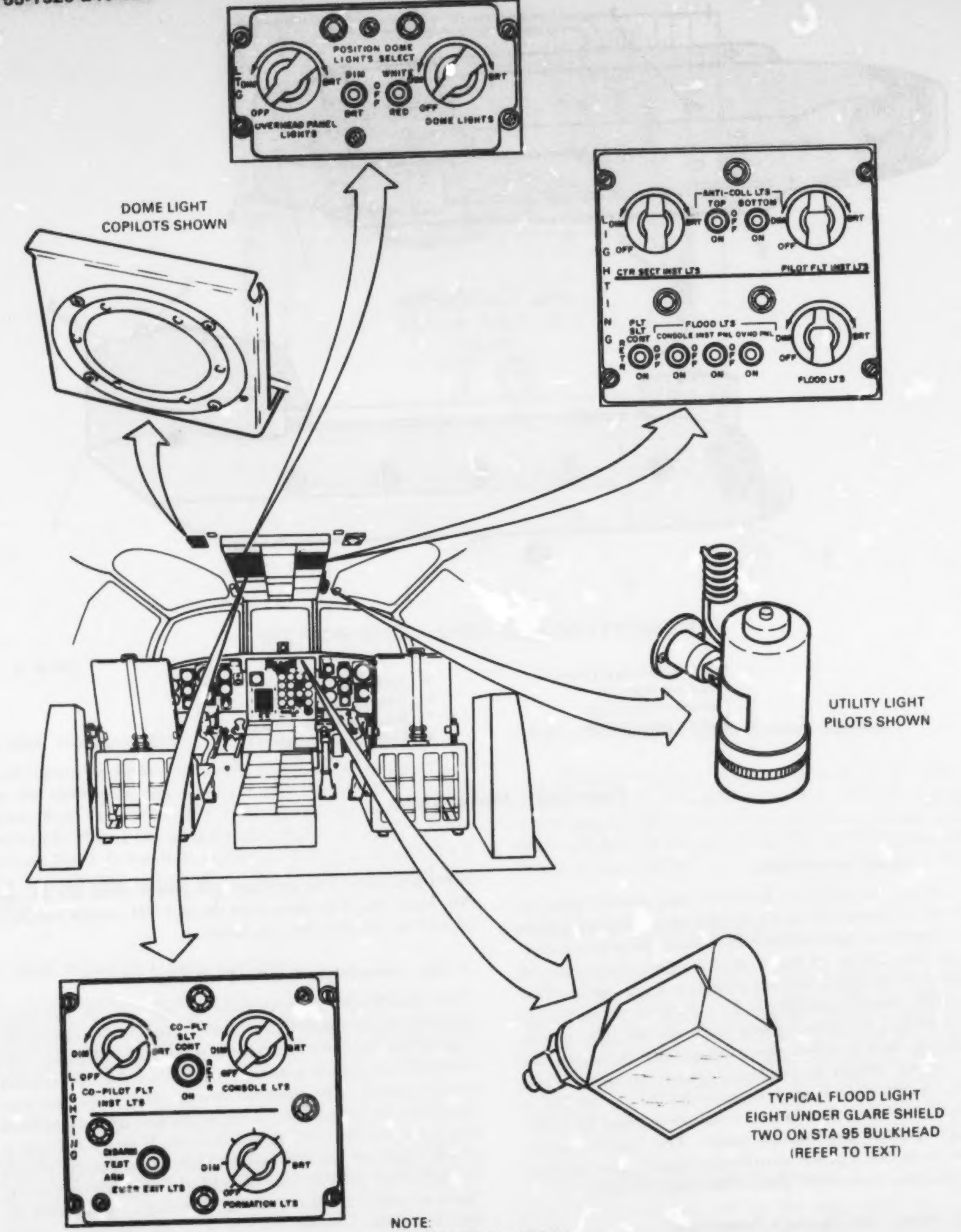
Two controllable 450-watt quartz landing-search lights (8, fig. 2-38) are mounted on the bottom of the fuselage. Each light is operated independently by a filament switch, a control switch, and a position switch. Each light can be extended or retracted into the fuselage. Each can be stopped at any desired position in its extension arc of 90°. It will rotate in a horizontal plane to the left or right. It will continue to turn in either direction as long as the searchlight control switch is displaced. Power to operate the landing-search light lamp is supplied by the 28-volt No. 1 and No. 2 dc buses thru circuit breakers marked SLT FIL on each power distribution panel. The pilot's circuit breaker is on No. 2 power distribution panel. The copilot's circuit breaker is on No. 1 power distribution panel.

2-212. Pilot's and Copilot's Searchlight Filament Switches.

The pilot's and copilot's searchlight filament switches are on the respective thrust control rod switch bracket. (See fig. 2-21.) Both switches have two positions, OFF and ON. The switches turn on the landing-search light lamp, before or after extension. The switches get power from the 28-volt No. 1 and No. 2 dc buses thru the SLT FIL circuit breakers on each power distribution panel.

2-213. Searchlight Control Switches.

Two searchlight control switches are on the overhead lighting control panel (fig. 2-39). The pilot's searchlight control switch is on the right lighting control panel. The copilot's searchlight control switch is on the left lighting control panel. The control switch allows the position switch on the thrust control rod to become operational and also to retract the landing-search light. If the searchlight is at any angle off center when the searchlight control switch is moved to RETR, the searchlight will automatically rotate to point forward and then will retract flush with the fuselage. The control switch is a two-position toggle switch with positions marked ON and RETR. The switches receive power from 28-volt No. 1 and No. 2 dc buses thru circuit breakers marked SLT CONT on each power distribution panel. The pilot's circuit breaker is on No. 2 power distribution panel. The copilot's circuit breaker is on No. 1 power distribution panel.


POSITION DOME LIGHTS SELECT
LIGHTING
DIM
BRT
OFF
OVERHEAD PANEL LIGHTS
DIM
OFF
BRT
WHITE
OFF
RED
DIM
BRT
OFF
DOME LIGHTS
DOME LIGHT COPILOTS SHOWN
LIGHTING
ANTI-COLL LTS
TOP
BOTTOM
OFF
ON
ON
DIM
BRT
OFF
CTR SECT INST LTS
DIM
BRT
OFF
PILOT FLT INST LTS
PLT SLT CONT
RETR
ON
FLOOD LTS
CONSOLE
INST PNL
OVHD PNL
OFF
ON
DIM
BRT
OFF
FLOOD LTS
UTILITY LIGHT PILOTS SHOWN
LIGHTING
DIM
BRT
OFF
CO-PILOT FLT INST LTS
CO-PLT SLT CONT
RETR
ON
DIM
BRT
OFF
CONSOLE LTS
DISARM
TEST
ARM
EMER EXIT LTS
DIM
BRT
OFF
FORMATION LTS
TYPICAL FLOOD LIGHT EIGHT UNDER GLARE SHIELD TWO ON STA 95 BULKHEAD (REFER TO TEXT)

NOTE:
SEE SERVICING DIAGRAM
FOR LOCATION OF FORWARD
TRANSMISSION OIL LEVEL
LIGHT AND SWITCH

D145-51-10

Figure 2-39. Cockpit Lighting and Controls

2-214. *Searchlight Position Switches.*

A five-position momentary switch is on each thrust control. When the filament and control switches are ON, the searchlight can be controlled up and down or left and right. The searchlight position switch gets power from the 28-volt No. 1 and No. 2 dc bus thru the SLT CONT circuit breaker on each power distribution panel. The pilot's circuit breaker is on No. 2 power distribution panel. The copilot's circuit breaker is on No. 1 power distribution panel.

2-215. *Normal Operation — Landing-Search Light.*

The landing-search light can be used for two separate functions: as a landing light or a searchlight. To cover a wide area with the searchlight, use the searchlight position switch on the thrust control. The searchlight may be extended and stopped at any angle up to 90° in a vertical plane and rotated 360° about its vertical axis.

a. SLT CONT switch — ON.

b. Pilot's or copilot's SLT-FIL switch — ON. For maximum light, both pilot's and copilot's searchlights should be used.

CAUTION

Do not confuse the searchlight control switch with the two engine beep trim switches.

c. SEARCH LIGHT position switch — EXTEND.

2-216. Overhead Panel Lights.

The overhead switch panel has integral lighting. Power to operate and control the overhead panel lights is supplied by the 28-volt No. 1 dc bus thru a circuit breaker marked OVHD PNL on the lighting section of No. 1 power distribution panel.

2-217. *Overhead Panel Lights Dimming Rheostat.*

The left overhead panel lights dimming rheostat is on the left lighting control panel of the overhead switch panel (3, fig. 2-39). The rheostat adjusts the amount of light. The rheostat is marked OVERHEAD PANEL LIGHTS. It controls the light level from BRT to DIM and OFF.

2-218. Pilot's and Copilot's Flight Instrument Lights.

All flight instruments and placards on both pilot's and copilot's instrument panels receive lighting. The horizontal situation indicator, rotor tachometer, magnetic compass, attitude indicator (VGI), AIMS altimeter, radar altimeter and rotor tachometer for both pilot and copilot have integral lighting. The remaining instruments are externally lit by lighting posts adjacent to the instruments. Power to operate and control the pilot's flight instrument lights is supplied by the 26 volt No. 2 lighting transformer thru the PILOT INSTR LIGHTING circuit breaker on No. 2 power distribution panel. Power to operate and control the copilot's flight instrument lights is supplied by the 26-volt No. 1 lighting transformer thru the COPLT INSTR LIGHTING circuit breaker on No. 1 power distribution panel.

2-219. *Pilot's and Copilot's Flight Instrument Lights Dimming Rheostat.*

The pilot's flight instrument lights dimming rheostat is on the right lighting control panel of the overhead switch panel (fig. 2-39). The copilot's flight instrument dimming rheostat is located on the left lighting control panel of the overhead switch panel. The rheostats are marked PILOT, COPILOT FLT INST LTS; both provide lighting control of the flight instruments from BRT to DIM and OFF.

2-220. Center Section Instrument Lights.

The center section instruments as well as the fire warning panel are lighted. Power to operate and control the center section lights is supplied by the 28-volt No. 2 dc bus thru a circuit breaker marked CTR INSTR on the No. 2 power distribution.

2-221. *Center Section Instrument Lights Dimming Rheostat.*

The center section instrument lights dimming rheostat is on the right lighting control panel of the overhead switch panel (fig. 2-39). The rheostat is marked CTR SECT INST LTS. The center section instrument dimming rheostat provides full control of the lighting from BRT to DIM and OFF, for the center section instruments.

2-222. Console Lights.

Lighting is provided for all control panels on the console. Power to operate and control the console lights is supplied by the 26 volt ac lighting transformer thru a circuit breaker, marked CONSOLE on the LIGHTING section of the No. 1 power distribution panel.

2-223. *Console Lights Dimming Rheostat.*

The console lights dimming rheostat is on the left lighting control panel of the overhead switch panel (fig. 2-39). The rheostat is marked CONSOLE LTS. The console lighting is controlled by the console dimming rheostat from BRT to DIM and OFF.

2-224. Dome Lights.

Two cockpit dome lights attached to the overhead structure adjacent to the overhead switch panel are provided (fig. 2-39). Each dome contains a white and red lamp which can be selected individually. Power to operate and control the dome lights is supplied by the 28-volt dc essential bus thru the COCKPIT DOME circuit breaker on the LIGHTING section of No. 2 power distribution panel. When the cockpit dome lights are on white, the master caution panels cannot be dimmed. If the white dome light is selected while the caution lights are operating on DIM, the caution lights will automatically switch to BRIGHT mode.

2-225. *Dome Lights Select Switch.*

A three-position switch on the left lighting control panel (fig. 2-39) of the overhead switch panel selects the function of the dome light. The switch is marked DOME SELECT switch positions WHITE, RED, and OFF.

2-226. Dome Lights Dimming Rheostat.

The dome lights dimming rheostat is on the left lighting control panel (fig. 2-39) of the overhead switch panel. When WHITE or RED is selected on the dome lights select switch, the dome lights dimming rheostat is operable thru a range from DIM to BRT. The dome lights dimming rheostat is marked DOME LIGHTS

2-227. Pilot's and Copilot's Utility Lights.

Two utility lights (fig. 2-39), connected to individual flexible cords, are mounted in two retaining sockets on either side of the overhead switch panel above the pilot and copilot. The lights are detachable and can be moved about to take care of special lighting situations. Each utility light has a rheostat switch as an integral part of its assembly. This switch, located on the aft part of the light, regulates the intensity of the light from OFF to BRT. A white button on the light housing, opposite the switch, is used for flashing the light. By selecting the color desired on the barrel of the light, red or white light will be emitted. The utility light receives power from the 28-volt No. 2 dc bus thru a COCKPIT DOME circuit breaker on the LIGHTING section of No. 2 power distribution panel.

2-228. Floodlights.

Ten floodlights (fig. 2-39) provide a secondary source of light. Eight are under the glare shield and two on the cockpit bulkhead. Six of the eight floodlights under the glareshield light the instrument panel; the other two light the console. The two overhead floodlights light the overhead switch panel. Power to operate and control the floodlights is supplied by the 28-volt dc essential bus thru a circuit breaker, marked INSTR FLOOD on the LIGHTING section of No. 2 power distribution panel.

2-229. Floodlights Dimming Rheostat.

The floodlights dimming rheostat is on the lower right lighting control panel (fig. 2-39) of the overhead switch panel. With the floodlight selection switches ON, the rheostat is used to turn the floodlights ON or OFF or control them from DIM to BRT.

2-230. Floodlight Selection Switches.

Three floodlight selection switches are on the lower right lighting control panel (fig. 2-39) of the overhead switch panel. Each two-position switch is labeled for the area the floodlights will light: FLOOD LTS CONSOLE, INST PNL, and OVHD PNL. By placing any one switch ON, the associated floodlights will light when the floodlight dimming rheostat is turned toward BRT. Moving the switch to OFF deenergizes the floodlight circuit.

2-231. Emergency Floodlights.

If the pilot's flight instrument lights have been turned on, loss of 28-volt No. 1 dc bus, or loss of 115-volt ac from the No. 1 ac bus, will cause the floodlights (para 2-228) to automatically come on. All floodlights except the two on the console will function automatically in the BRIGHT mode. The console floodlights can be turned on by selecting the console floodlights switch to ON and adjusting the floodlight dimming rheostat. Simultaneous dimming control of all floodlights can be regained by setting the three floodlight selection switches ON, turning the floodlight dimming rheostat to BRT, and turning the pilot's flight instrument dimming rheostat to OFF. Floodlight intensity can be controlled by the floodlight dimming rheostat.

2-232. Cabin and Ramp Lights.

Five cabin and ramp lights (fig. 2-40) are in the cabin, attached to the overhead structure. Each light contains a white and red lamp which can be selected individually. Power to operate and control the cabin and ramp lights is supplied by the 28-volt dc switched battery bus thru a CABIN & RAMP circuit breaker on the LIGHTING section of No. 1 power distribution panel.

2-233. Cabin and Ramp Red Light Control Switches.

The red light control switches (fig. 2-40) are three-position momentary toggle switches. One switch is on the CABIN AND RAMP LIGHTS placard below the ramp control lever. The second switch is on the CABIN AND RAMP LIGHTS placard on the right side of the passageway. When the switch is moved to RED ON, the red cabin-light relay is energized and electrically locks the red lights on. Moving the switch to ALL OFF deenergizes both red and white light relays.

2-234. Cabin and Ramp White Light Control Switch.

The white light control switch is a two-position momentary button switch on the CABIN AND RAMP LIGHTS placard (fig. 2-40) on the right side of the passageway. When the switch is pushed to WHITE ON, the white cabin-light relay is energized. This electrically locks the white lights on. The white lights cannot be turned off until ALL OFF position is selected on either of the red light control switches.

2-235. Emergency Exit Lighting.

Three emergency exit lights are in the cargo compartment close to each of the three primary emergency exits: the main cabin door, the emergency exit opposite the main cabin door, and the ramp emergency exit. The lights (fig. 2-41) come on whenever a loss of power on the switched battery bus occurs or during a landing when 3 to 4g are exceeded as sensed by an inertia switch. The lights may also be used as portable lamps by removing them from their housing and by rotating the handle, marked PULL EMERGENCY LIGHT, 45° from its normal position. Power to operate the emergency exit lights is supplied by two, internal, 1.25 volt, nickel-cadmium batteries. Power to operate and control the charging, monitoring, and test circuit is supplied by the 28-volt dc switched battery bus thru the CABIN & RAMP circuit breaker on the LIGHTING section of No. 1 power distribution panel. The emergency exit lights system is controlled by the emergency exit lights control switch on the overhead panel.

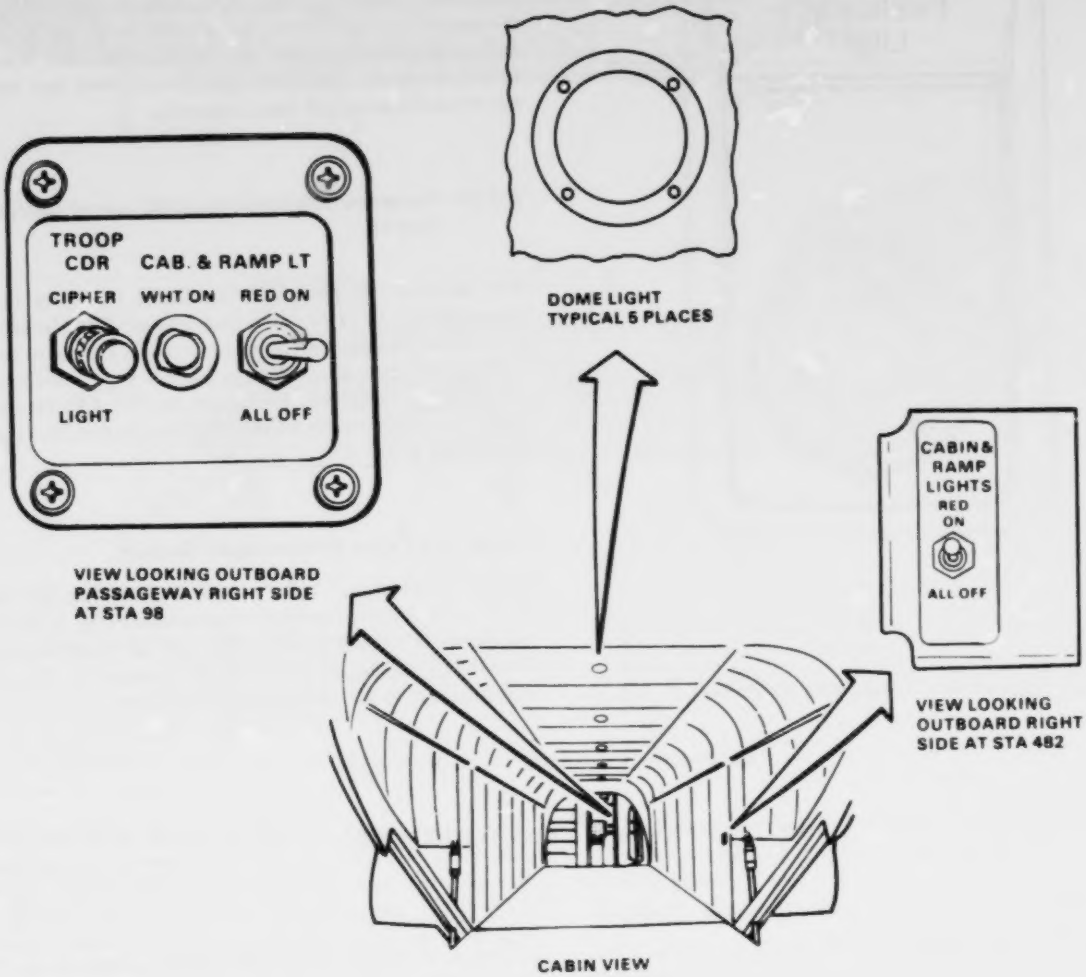

TROOP CDR
CAB. & RAMP LT
CIPHER
WHT ON
RED ON
LIGHT
ALL OFF
VIEW LOOKING OUTBOARD PASSAGEWAY RIGHT SIDE AT STA 98
DOME LIGHT TYPICAL 5 PLACES
CABIN & RAMP LIGHTS
RED ON
ALL OFF
VIEW LOOKING OUTBOARD RIGHT SIDE AT STA 482
CABIN VIEW

Figure 2-40. Cabin Lighting and Controls

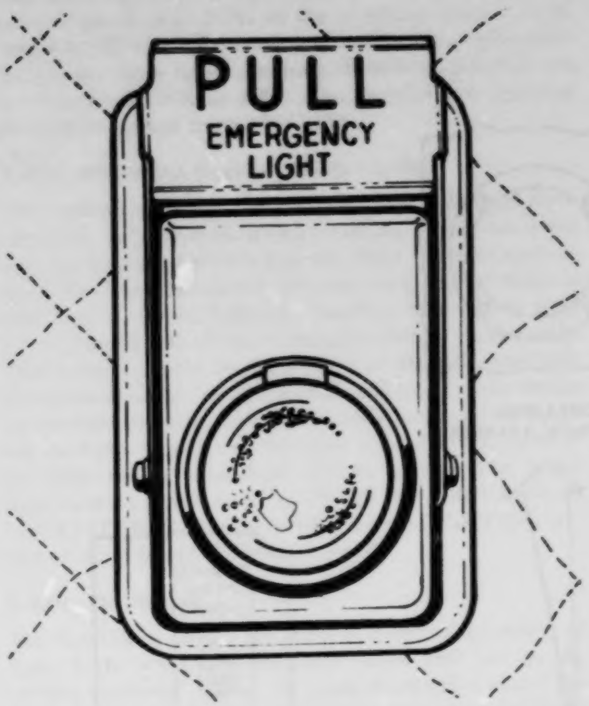


Figure 2-41. Emergency Exit Light

2-236. Emergency Exit Lights Control Switch.

The EMER EXIT LTS control switch is on the lower left lighting control panel (fig. 2-41.2) of the overhead switch panel. The switch has three positions marked: ARM, TEST, and DISARM. When the switch is moved to ARM, the circuit monitors electrical failures and landings in excess of 3 to 4g. When the switch is set to TEST, the main light comes on, powered by the batteries. When the switch is set to DISARM, the circuit does not monitor electrical failures and hard landings.

2-237. Forward Transmission Oil Level Check Lights.

The forward transmission floodlight provides light to check the oil level of the transmission. The floodlight is near the sight gage on the transmission. Power to operate and control the oil level check light is supplied by the 28-volt dc switched battery bus thru an OIL LEVEL CHECK circuit breaker on the LIGHTING section of No. 1 power distribution panel.

2-238. Oil Level Check Light Switch.

One oil level check light switch is provided for the oil check light for the forward transmission (fig. 2-39). It is a two-position switch marked OIL LEVEL CHECK LT SW, ON-OFF. The switch is inside the cockpit on the canted bulkhead at sta 95 above the pilot's seat.

SECTION XIII.I LIGHTING NVG

2-238.1. Position Lights (NVG).

Three position lights (1, 4 and 6, figure 2-41.1) are installed on the helicopter. On the right side of the fuselage is a green light (1); on the left, red (6); and on the aft pylon, white (4). Power for the position lights is supplied by the 28-volt No. 2 dc bus thru a circuit breaker marked POS on the LIGHTING section of the No. 2 power distribution panel.

2-238.2. Position Lights Switch (NVG).

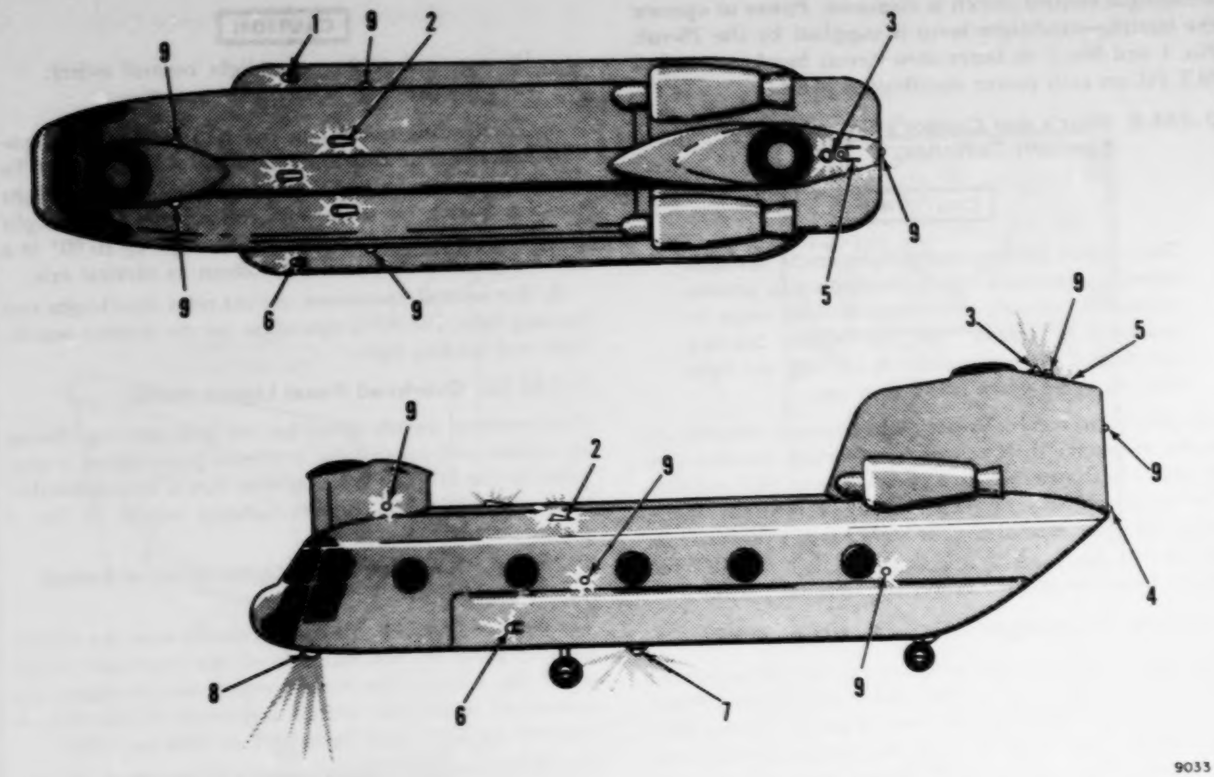
A three-position toggle switch on the exterior lighting panel on the left side (fig. 2-8.1) of the overhead switch panel controls the position lights. The switch is marked POS DIM-OFF-BRT.

2-238.3. Formation Lights (NVG).

There are five electroluminescent panels for normal night formation operations and eight NVG compatible formation lights for NVG formation operations (fig. 2-41.1). Three panels which form an equilateral triangle are aft of the forward pylon. Two panels are on the top of the aft pylon aft of the anticollision light. There is an NVG formation light on each side of the forward pylon, two NVG formation lights on each side of the fuselage and two NVG formation lights on the aft pylon, one aft of the anti-collision light, and one on the vertical panel at the rear of the aft pylon. Power to operate and control the electroluminescent formation lights is supplied by the 115-volt No. 1 ac bus thru the FORM circuit breaker on the LIGHTING section of the No. 1 power distribution panel. Power to operate and control the NVG formation lights is supplied by the 28-volt No. 1 dc bus thru the "NVG FORM" circuit breaker on the lighting section of the No. 1 power distribution panel.

2-238.4. Formation Lights Select Switch (NVG).

The formation lights select switch is on the exterior lighting panel (fig. 2-8.1) on the left side of the overhead switch panel. The two-position toggle switch is marked



1. Right position light (Green)
2. Formation lights (3)
3. Top anticollison light
4. Position light (White)
5. Formation lights (2)
6. Left position light (Red)
7. Bottom anticollision light
8. Landing-search lights (2)
9. NVG formation lights (8)

Figure 2-41.1. Exterior Lights (NVG)

NORM and NVG. In the NORM position, the five electroluminescent panels may be controlled by the formation light rotary control switch for normal night formation operations. In the NVG position, the eight NVG formation lights may be controlled by the formation light rotary control switch for NVG night formation operation.

2-238.5. Formation Lights Control Switch (NVG).

The formation lights control switch is on the exterior lighting panel (fig. 2-8.1) on the left side of the overhead switch panel. The rotary control switch controls the intensity of the formation lights selected by the formation lights select switch. The rotary control switch is marked OFF, DIM and BRT with three evenly spaced incremental markings between dim and bright. When the rotary control switch is OFF, the formation light system is deenergized.

2-238.6. Anticollision Lights (NVG).

Two red strobe anticollision lights (3 and 7, fig. 2-41.1) are on the helicopter. One is on top of the aft pylon; the other is on the fuselage underside. Power to operate the anticollision lights is supplied by the 28-volt No. 2 dc bus thru two circuit breakers labeled ANTI-COL TOP and BOT on the LIGHTING section of the No. 2 power distribution panel.

2-238.7. Anticollision Light Switches (NVG).

Two toggle switches are on the exterior lighting panel (fig. 2-8.1) on the left side of the overhead switch panel. The two-position switches are marked ANTI-COL TOP and BOT. Each switch has ON and OFF positions. When the anticollision light switch is ON, the lights are energized. When the switch is moved to OFF, the anticollision lights are deenergized.

2-238.8 Landing Searchlights (NVG).

Two controllable landing-searchlights (8, fig. 2-41.1) are mounted on the bottom of the fuselage. One is controlled from the pilot's thrust control rod, the other from the copilot's thrust control rod. The copilot light is equipped with an infrared (IR) filter for NVG operations. Each light is operated independently by a filament switch, a control switch, and a position switch. Each light can be extended or retracted into the fuselage. Each can be stopped at any desired position in its extension arc of 90°. It will rotate in a horizontal plane to the left or right. It will continue to turn in either direction as long as the searchlight control switch is displaced. Power to operate the landing-searchlight lamp is supplied by the 28-volt No. 1 and No. 2 dc buses thru circuit breakers marked SLT FIL on each power distribution panel.

2-238.9. Pilot's and Copilot's Searchlight Filament Switches.

CAUTION

The copilot landing searchlight emits invisible infrared rays which may be hazardous to personnel looking directly at the light at close range, or touching it. Ensure that the copilot landing searchlight filament switch is off and the light fully retracted when it is not in use.

The pilot's and copilot's searchlight filament switches are on the respective thrust control rod switch bracket. (See fig. 2-21.) Both switches have two positions, OFF and ON. The switches turn on the landing-searchlight lamp, before or after extension. The switches get power from the 28-volt No. 1 and No. 2 dc buses thru the SLT FIL circuit breakers on each power distribution panel.

2-238.10. Searchlight Control Switches (NVG).

Two searchlight control switches are on the overhead switch panel (fig. 2-41.2). The pilot's searchlight control switch is on the pilot lighting control panel. The copilot's searchlight control switch is on the copilot lighting control panel. The control switch allows the position switch on the thrust control rod to become operational and also to retract the landing-searchlight. If the searchlight is at any angle off center when the searchlight control switch is moved to RET, the searchlight will automatically rotate to point forward and then will retract flush with the fuselage. The control switch is a two-poisition toggle switch with positions marked ON and RET. The switches receive power from 28-volt No. 1 and No. 2 dc buses thru circuit breakers marked SLT CONT on each power distribution panel. The pilot's circuit breaker is on No. 2 power distribution panel. The copilot's circuit breaker is on No. 1 power distribution panel.

2-238.11. Searchlight Position Switches (NVG).

A five-position momentary switch is on each thrust control. When the filament and control switches are ON, the searchlight can be controlled up and down or left and right. The searchlight position switch gets power from the 28-volt No. 1 and No. 2 dc bus thru the SLT CONT circuit breaker on each power distribution panel. The pilot's circuit breaker is on No. 2 power distribution panel. The copilot's circuit breaker is on No. 1 power distribution panel.

2-238.12. Normal Operation — Landing-Searchlight (NVG).

CAUTION

Light from the pilot's landing searchlight may severely impair the effectiveness of night vision goggles. Do not turn on the pilot landing searchlight when night vision goggles are being used.

CAUTION

Do not confuse the searchlight control switch with the two engine beep trim switches.

a. The landing-searchlight can be used for two separate functions: as a landing light or a searchlight. To cover a wide area with the searchlight, use the searchlight position switch on the thrust control. The searchlight may be extended and stopped at any angle up to 90° in a vertical plane and rotated 360° about its vertical axis.

b. For normal operations use the pilot searchlight and landing light. For NVG operation use the copilot searchlight and landing light.

2-238.13. Overhead Panel Lights (NVG).

The overhead switch panel has integral lighting. Power to operate and control the overhead panel lights is supplied by the 115-volt No. 1 ac bus thru a circuit breaker marked OVHD PNL on the lighting section of No. 1 power distribution panel.

2-238.14. Overhead Panel Lights Control Switch (NVG).

The overhead panel lights control switch is on the copilot lighting panel on the left side of the overhead switch panel (fig. 2-41.2). The rotary control switch adjusts the amount of lights. The switch is marked OVHD CSL. It controls the light level from BRT to DIM and OFF.

2-238.15. Pilot's and Copilot's Flight Instrument Lights (NVG).

All flight instruments and placards on both pilot's and copilot's instrument panels receive lighting. The horizontal situation indicator, attitude indicator (VGI), radar altimeter and turn and slip indicator for both pilot and copilot have integral lighting. The remaining instruments are externally lit by lighting posts adjacent to the instruments. Power to operate and control the pilot's flight instrument lights is supplied by the 115-volt No. 2 ac bus thru the PILOT INSTR LIGHTING circuit breaker on the No. 2 power distribution panel. Power to operate and control the copilot's flight instrument lights is supplied by the 115-volt No. 1 ac bus thru the COPLT INSTR LIGHTING circuit breaker on No. 1 power distribution panel.

2-238.16. Pilot's and Copilot's Flight Instrument Lights Control Switches (NVG).

The pilot's flight instrument lights control switch is on the pilot lighting panel on the right side of the overhead switch panel (fig. 2-41.2). The copilot's flight instrument control switch is located on the copilot lighting panel on the left side of the overhead switch panel. The rotary control switches are marked PILOT, COPILOT FLT INST LTS; both provide lighting control of the flight instruments from BRT to DIM and OFF.

2-238.17. Center Section Instrument Lights (NVG).

The center section instruments as well as the fire warning panel are lighted. Power to operate and control the

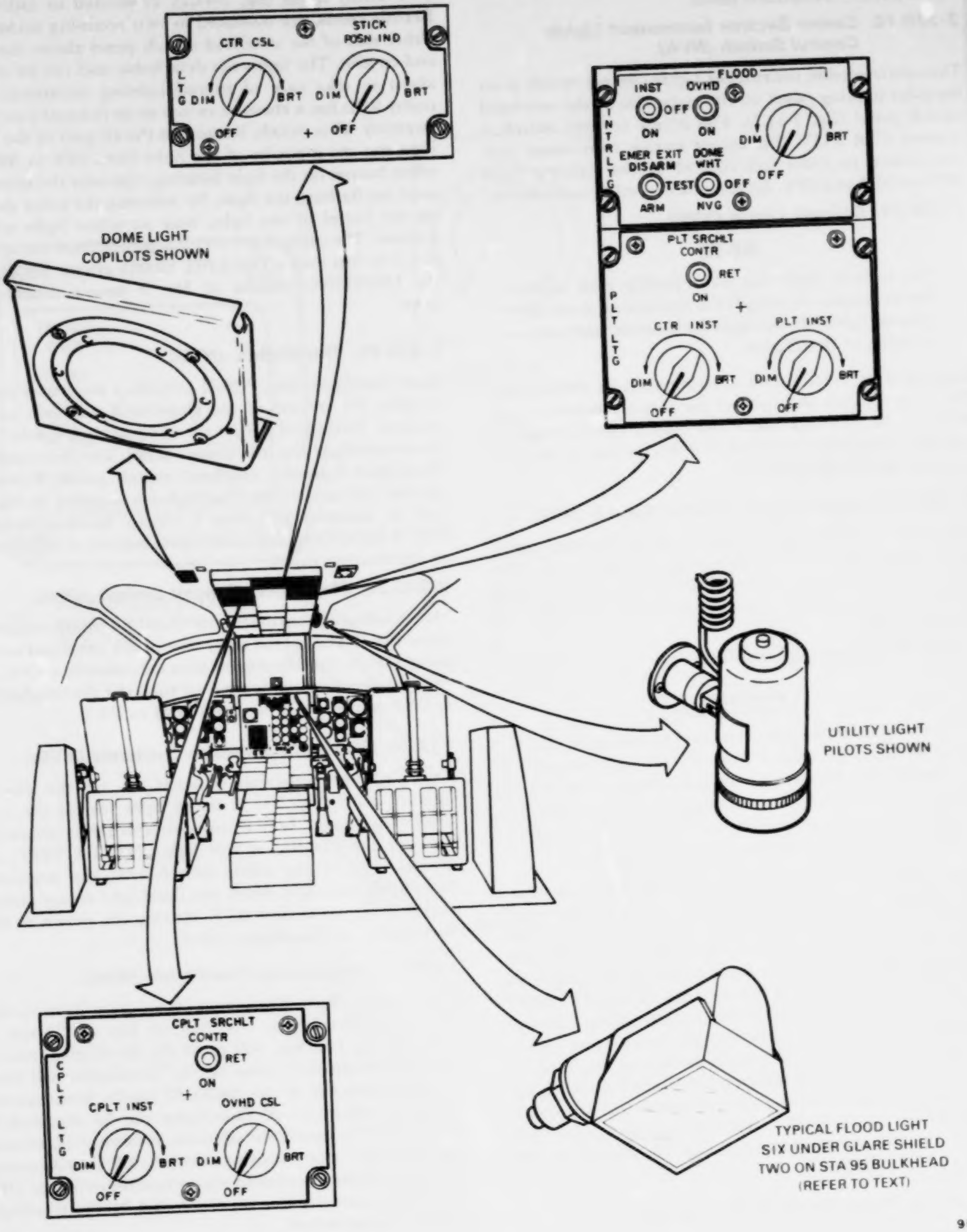

STICK POSN IND
CTR CSL
LTG
DIM
BRT
OFF
DOME LIGHT COPILOTS SHOWN
FLOOD
INST
OVHD
OFF
ON
INTR LTG
EMER EXIT DISARM
DOME WHT
TEST
ARM
NVG
PLT SRCHLT CONTR
RET
PLT LTG
CTR INST
PLT INST
UTILITY LIGHT PILOTS SHOWN
CPLT SRCHLT CONTR
CPLT LTG
CPLT INST
OVHD CSL
TYPICAL FLOOD LIGHT SIX UNDER GLARE SHIELD TWO ON STA 95 BULKHEAD (REFER TO TEXT)
9034

Figure 2-41.2. Cockpit Lighting and Control (NVG)

center section lights is supplied by the 115-volt No. 2 ac bus thru a circuit breaker marked CTR INSTR on the No. 2 power distribution panel.

2-238.18. Center Section Instrument Lights Control Switch (NVG).

The center section instrument lights control switch is on the pilot lighting panel on the right side of the overhead switch panel (fig. 2-41.2). The rotary control switch is marked CTR INST. The center section instrument control switch provides full control of the lighting from BRT to DIM and OFF, for the center section instruments.

2-238.19. Console Lights (NVG).

NOTE

> The console lights are incompatible with night vision goggles. During NVG operations, turn the console lights off and light the console with utility lights or floodlights.

Lighting is provided for all control panels on the console. Power to operate and control the console lights is supplied by the 115 volt No. 1 bus thru a circuit breaker, marked CONSOLE on the LIGHTING section of the No. 1 power distribution panel.

2-238.20. Console Lights Control Switch (NVG).

The console lights control switch is on the lighting panel at the rear of the overhead switch panel (fig. 2-41.2). The rotary control switch is marked CTR CSL. The console lighting is controlled by the control switch from BRT to DIM and OFF.

2-238.21. Dome Lights (NVG).

WARNING

> If the white dome light is turned on during NVG operations, the effectiveness of the night vision goggles may be severely impaired and a hazardous situation may be created due to sudden loss of pilot visual references. Do not turn on the white dome lights during NVG operations.

Two cockpit dome lights attached to the overhead structure adjacent to the overhead switch panel are provided (fig. 2-41.2). Each dome contains a white lamp and a blue NVG filtered lamp which can be selected individually. Power to operate and control the dome lights is supplied by the 28-volt dc essential bus thru the COCKPIT DOME circuit breaker on the LIGHTING section of No. 2 power distribution panel. When the cockpit dome lights are on white, the master caution panels cannot be dimmed. If the white dome light is selected while the caution lights are operating on DIM, the caution lights will automatically switch to BRIGHT mode. During operation with NVG, the dome light switch should be selected to the NVG position only.

2-238.22. Dome Lights Select Switch.

A three-position switch on the interior lighting panel (fig. 2-41.2) at the right rear of the overhead switch panel selects the function of the dome light. The switch is marked DOME WHITE, NVG and OFF.

2-238.23. Pilot's and Copilot's Utility Lights.

Two utility lights (fig. 2-41.2), connected to individual flexible cords, are mounted in two retaining sockets on either side of the overhead switch panel above the pilot and copilot. The lights are detachable and can be moved about to take care of special lighting situations. Each utility light has a rheostat switch as an integral part of its assembly. This switch, located on the aft part of the light, regulates the intensity of the light from OFF to BRT. A white button on the light housing, opposite the switch, is used for flashing the light. By selecting the color desired on the barrel of the light, blue or white light will be emitted. The utility light receives power from the 28-volt No. 2 dc bus thru a COCKPIT DOME circuit breaker on the LIGHTING section of No. 2 power distribution panel.

2-238.24. Floodlights. (NVG)

Eight floodlights (fig. 2-41.2) provide a secondary source of light. Six are under the glareshield and two on the cockpit bulkhead. The six floodlights under the glareshield light the instrument panel. The two overhead floodlights light the overhead switch panel. Power to operate and control the floodlights is supplied by the 28-volt dc essential bus thru a circuit breaker, marked INSTR FLOOD on the LIGHTING section of No. 2 power distribution panel.

2-238.25. Floodlights Control Switch (NVG).

The floodlights control switch is on the interior lighting panel (fig. 2-41.2) at the right rear of the overhead switch panel. With the floodlight selection switches ON, the rotary control switch is used to turn the floodlights ON or OFF or control them from DIM to BRT.

238.26. Floodlight Selection Switches (NVG).

Two floodlight selection switches are on the interior lighting panel (fig. 2-41.2) at the right rear of the overhead switch panel. Each two-position switch is labeled for the area the floodlights will light: FLOOD, INST, and OVHD. By placing either switch ON, the associated floodlights will light when the floodlight rotary control switch is turned toward BRT. Moving the switch to OFF deenergizes the floodlight circuit.

2-238.27. Emergency Floodlights (NVG).

If the pilot's flight instrument lights have been turned on, loss of 28-volt No. 1 dc bus, or loss of 115-volt ac from the No. 1 ac bus, will cause the floodlights (para 2-228) to automatically come on. All floodlights will function automatically in the BRIGHT mode. Simultaneous dimming control of all floodlights can be regained by setting the two floodlight selection switches ON, turning the floodlight rotary control switch to BRT, and turning the pilot's flight instrument rotary control switch to OFF. Floodlight intensity can be controlled by the floodlight rotary control switch.

2-238.28. Cabin and Ramp Lights (NVG).

Five cabin and ramp lights (fig. 2-41.3) are in the cabin, attached to the overhead structure. Each light contains an

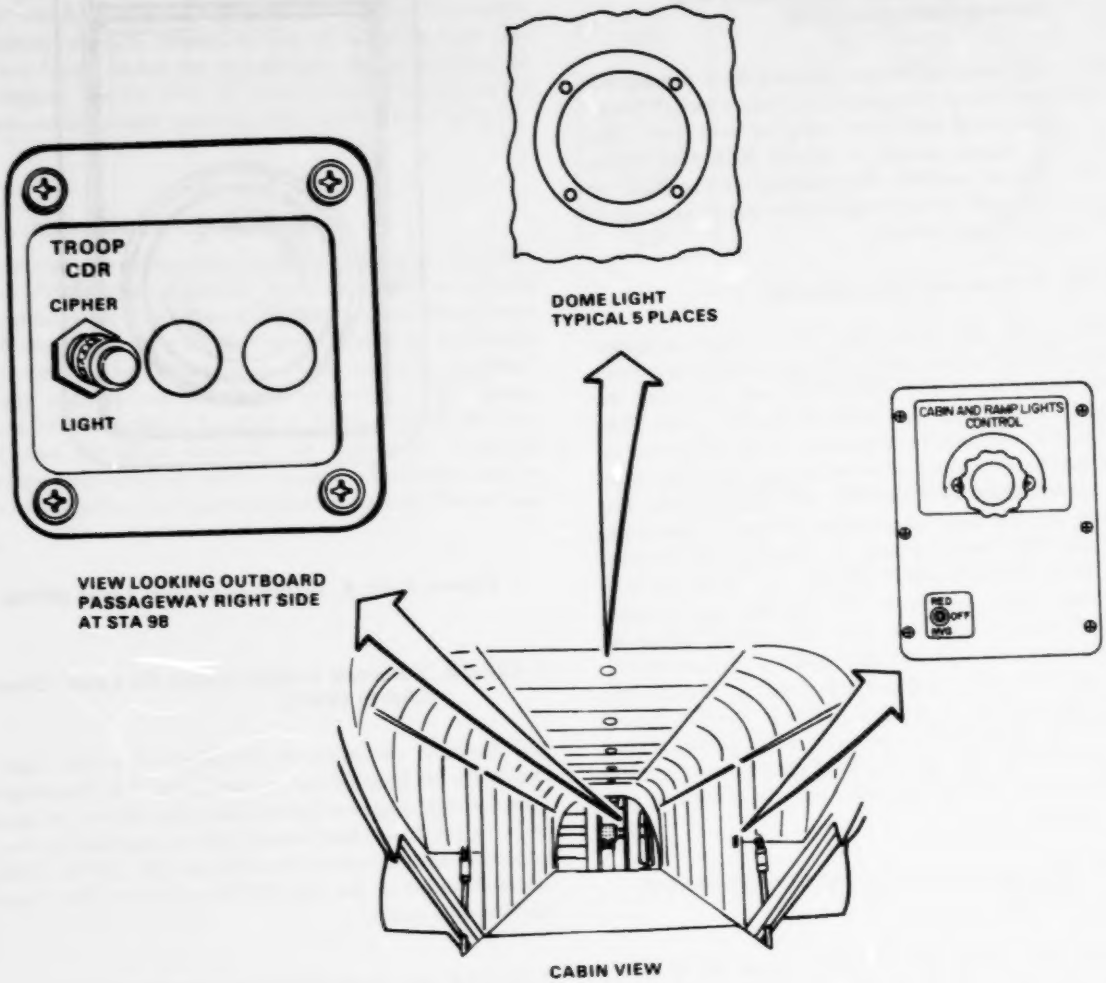

DOME LIGHT
TYPICAL 5 PLACES
TROOP
CDR
CIPHER
LIGHT
VIEW LOOKING OUTBOARD
PASSAGEWAY RIGHT SIDE
AT STA 98
CABIN AND RAMP LIGHTS
CONTROL
RED
OFF
NVG
CABIN VIEW
9035

Figure 2-41.3. Cabin Lighting and Controls (NVG)

NVG blue lamp and a red lamp which can be selected individually. Power to operate and control the cabin and ramp lights is supplied by the 28-volt dc switched battery bus thru a CABIN & RAMP circuit breaker on the LIGHTING section of No. 1 power distribution panel.

2-238.29. Cabin and Ramp Light Select and Control Switches (NVG).

The cabin and ramp lights are selected by a three-position toggle switch and controlled by a rotary switch located on a control panel below the ramp control lever. The three-position toggle switch is labeled RED-OFF-NVG. The rotary switch controls the intensity of the RED or NVG lights from off to full bright when either position is selected on the toggle switch.

2-238.30. Emergency Exit Lighting.

Three emergency exit lights are in the cargo compartment close to each of the three primary emergency exits: the main cabin door, the emergency exit opposite the main cabin door, and the ramp emergency exit. The lights (fig. 2-41.4) come on whenever a loss of power on the switched battery bus occurs or during a landing when 3 to 4g are exceeded as sensed by an inertia switch. The lights may also be used as portable lamps by removing them from their housing and by rotating the handle, marked PULL EMERGENCY LIGHT, 45° from its normal position. Power to operate the emergency exit lights is supplied by two, internal, 1.25 volt, nickel-cadmium batteries. Power to operate and control the charging, monitoring, and test circuit is supplied by the 28-volt switched battery bus thru the CABIN & RAMP circuit breaker on the LIGHTING section of No. 1 power distribution panel. The emergency exit lights system is controlled by the emergency exit lights control switch on the overhead panel.

2-238.31. Emergency Exit Lights Control Switch (NVG).

The EMER EXIT lights control switch is on the interior lighting panel (fig. 2-41.2) on the right rear of the overhead switch panel. The switch has three positions marked: ARM, TEST, and DISARM. When the switch is moved to ARM, the circuit monitors electrical failures and landings in excess of 3 to 4g. When the switch is set to TEST, the main light comes on, powered by the batteries. When the switch is set to DISARM, the circuit does not monitor electrical failures and hard landings.

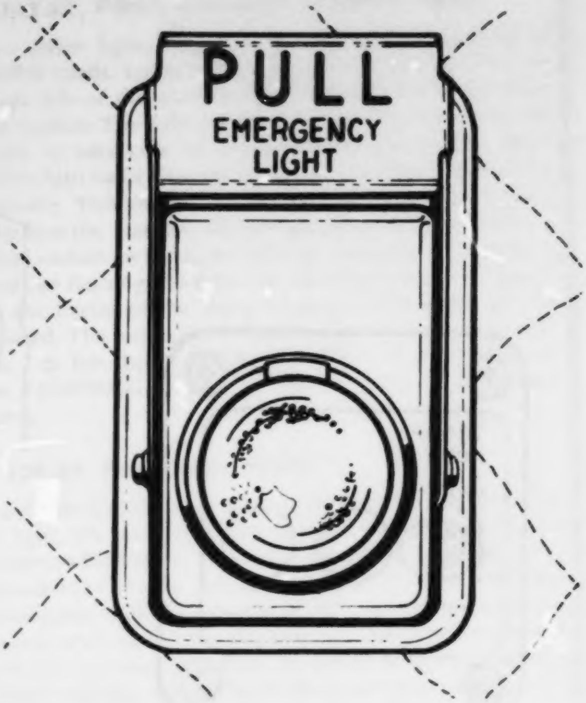


Figure 2-41.4. Emergency Exit Light (NVG)

2-238.32. Forward Transmission Oil Level Check Lights (NVG).

The forward transmission floodlight provides light to check the oil level of the transmission. The floodlight is near the sight gage on the transmission. Power to operate and control the oil level check light is supplied by the 28-volt dc switched battery bus thru an OIL LEVEL CHECK circuit breaker on the LIGHTING section of No. 1 power distribution panel.

2-238.33. Oil Level Check Light Switch.

One oil level check light switch is provided for the oil check light for the forward transmission. It is a two-position switch marked OIL LEVEL CHECK LT SW, ON-OFF. The switch is inside the cockpit on the canted bulkhead at sta 95 above the pilot's seat.

2-239. Deleted.

SECTION XIV FLIGHT INSTRUMENTS

2-240. General.

The following paragraphs contain information on the flight instruments. Information on the navigation instruments will be found in chapter 3, Avionics. All other instruments directly related to one of the helicopter systems are found under the appropriate system heading in this chapter. See fig. 2-6, 2-7, and 2-8 for illustrations of the instrument panels, console, and overhead switch panel.

2-241. Cruise Guide Indicator System.

The cruise guide indicator system (fig. 2-42) gives the pilot a visual indication of actual loads imposed on critical components of the helicopter dynamic system. The system allows the pilot to achieve maximum helicopter utilization under various conditions of payload, altitude, airspeed, ambient temperature and center-of-gravity. The system consists of strain gages bonded to fixed links in the forward and aft rotor controls, an indicator, a signal processor unit in the aft pylon, a signal conditioner unit in the forward pylon, and interconnecting wiring. The system

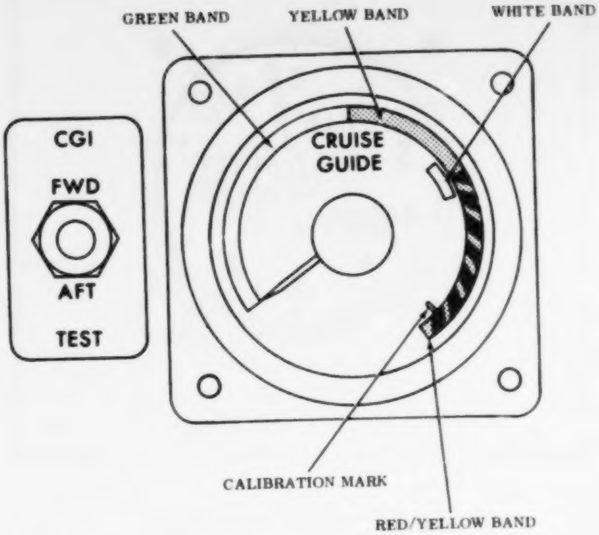


Figure 2-42. Cruise Guide Indicator

measures alternating stress loads and displays the larger of the two signals. The system is powered by No. 2 28-vdc bus thru the CRUISE GUIDE circuit breaker on the No. 2 power distribution panel.

2-242. Cruise Guide Indicator.

Refer to figure 5-1 for limitations. The cruise guide indicator (fig. 2-42) is on the pilot's instrument panel. Three bands are displayed on the dial face of the indicator. Operation in the red-and-yellow striped band shall be avoided. Immediate corrective action must be taken to reduce stress. This can be accomplished by lowering thrust, reducing airspeed, releasing back pressure on the cyclic stick, or by reducing the severity of the maneuver.

2-243. Cruise Guide Indicator Test Switch.

The cruise guide indicator test switch (fig. 2-42) is on the pilot's instrument panel, on the left side of the indicator. It is a three-position switch, spring loaded to center. The switch is marked CGI TEST, FWD, and AFT. When the switch is moved from center position to each test position, the pointer should indicate within the white test band. The white test band indicates proper system operation.

NOTE

Do not test the cruise guide system with rotors turning. False indications will result.

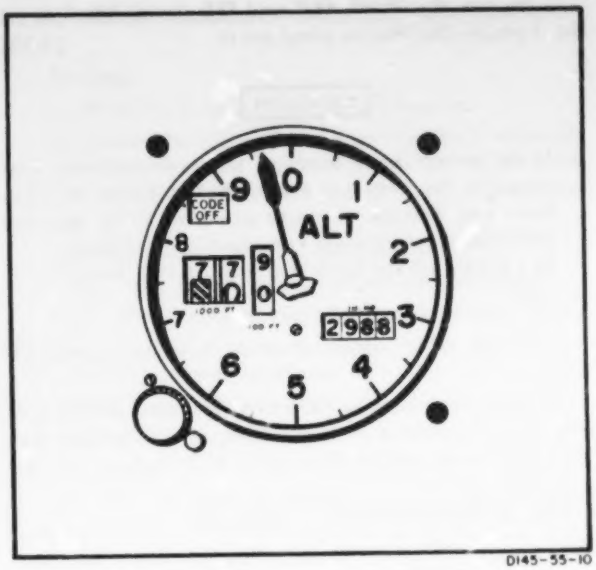
The test circuit tests the circuits from the strain gages to the indicator. However, separation of the bond of the strain gage to a link will not be detected by the test function. The narrow white line towards the high end of the avoid band is used for calibrating the indicator during bench test.

2-244. Airspeed Indicator.

There are two airspeed indicators (fig. 2-7). These indicators are in the upper left portion of the pilot's and copilot's instrument panels. The difference between dynamic pressure and static pressure as measured by the pitot static system is introduced into these instruments, and indicated as airspeed in knots.

2-245. Altimeter.

An AIMS altimeter (fig. 2-43) is provided for the pilot. A pneumatic counter-drum-pointer type altimeter is installed for the copilot. The pilot's altimeter is a pneumatic counter-drum-pointer type which is a self-contained unit consisting of a precision pressure altimeter combined with an altitude encoder. The display indicates and the encoder transmits through the transponder, simultaneously, the altitude of the helicopter. Altitude is displayed on the altimeter by a 10,000-foot counter, and a 100-foot drum. A single pointer indicates hundreds of feet on a circular scale with 50-foot center markings. Below 10,000 feet, a diagonal warning symbol will appear on the 10,000 foot counter. A barometric pressure setting knob is provided to insert the desired altimeter setting in inches of Hg. A vibrator powered by No. 2 dc bus is contained in the altimeter and requires a minimum of 1 minute warmup prior to checking or setting the altimeter. If dc power to the altitude encoder is lost, a warning flag placarded CODE OFF appears in the upper left instrument dial. The flag indicates that the altitude encoder is inoperative and that the system is not reporting altitude to ground stations. The CODE OFF flag monitors only the encoder function of the altimeter. It does not indicate transponder condition. The AIMS altitude reporting function can be inoperative without the CODE OFF flag showing, as in case of transponder failure or improper control settings. It is also possible to get a good Mode C test on the transponder control with the CODE OFF flag showing. Display of the CODE OFF flag only indicates an encoder power failure or a CODE OFF flag failure. In this event, check that dc power is available and that the circuit breakers are in. If the flag is still visible, radio contact should be made with a ground radar site to determine whether the AIMS altitude reporting function is operative. The remainder of the flight should be conducted accordingly.



D145-55-10

Figure 2-43. AIMS Altimeter

2-246. Preflight Operation — Altimeter.

If the AIMS altimeter encoding function is to be used during a flight, perform the following steps prior to takeoff:

a. Be sure the AIMS ALT and IFF circuit breakers on No. 2 power distribution panel are in.

CAUTION

If the baroset knob binds or sticks, do not use excessive force to set the altimeter. Excessive force can damage altimeter gears, resulting in altimeter error. Settings can sometimes be made by backing off the knob and turning at a slower rate.

b. Set the pilot's altimeter to the field barometric setting.

c. Check that the pilot's altimeter indicates within ±70 feet of field elevation. If the altimeter error is greater than ±70 feet, do not use the altimeter for IFR flight.

2-247. In Flight Operation — Altimeter.

Operate the AIMS altimeter encoding function as follows:

a. Be sure the IFF set is on and set to the proper code.

b. Be sure the altimeter is set to the local altimeter setting.

c. Set the M-C (mode c) switch on the IFF control panel to ON.

d. Check that the red CODE OFF flag is not visible in the pilot's altimeter.

The copilot's altimeter is a pneumatic counter-drum-pointer type which displays altitude in the same manner as the pilot's altimeter. It also incorporates a barometric pressure setting knob and an internal vibrator powered by the No. 2 dc bus. A minimum of 1 minute of vibrator operation is required prior to setting or checking the altimeter. At ambient pressure, both altimeters should agree, within ±70 feet of the field elevation when the proper barometric pressure setting is set in the altimeter. If the internal vibrator of either altimeter becomes inoperative due to dc power failure, the pointer drum may momentarily hang up when passing from 9 thru 0 (climbing) or from 0 to 9 (descending). This will cause a lag of magnitude which will depend on the vertical velocity of the aircraft and the friction in the altimeter.

2-248. Radar Altimeter (AN/APN-209A). Radar altimeters (fig. 2-44) are provided for the pilot and copilot. The altimeters provide a continuous indication of the height of the helicopter above the surface from 0 to 1,500 feet. Altimeter indications are reliable with pitch and roll attitude up to 45°. Altitude is displayed by a dial and pointer and by a digital display. Each altimeter has HI and LO caution lights. The caution lights on each altimeter can be set independently of the other altimeter. The caution

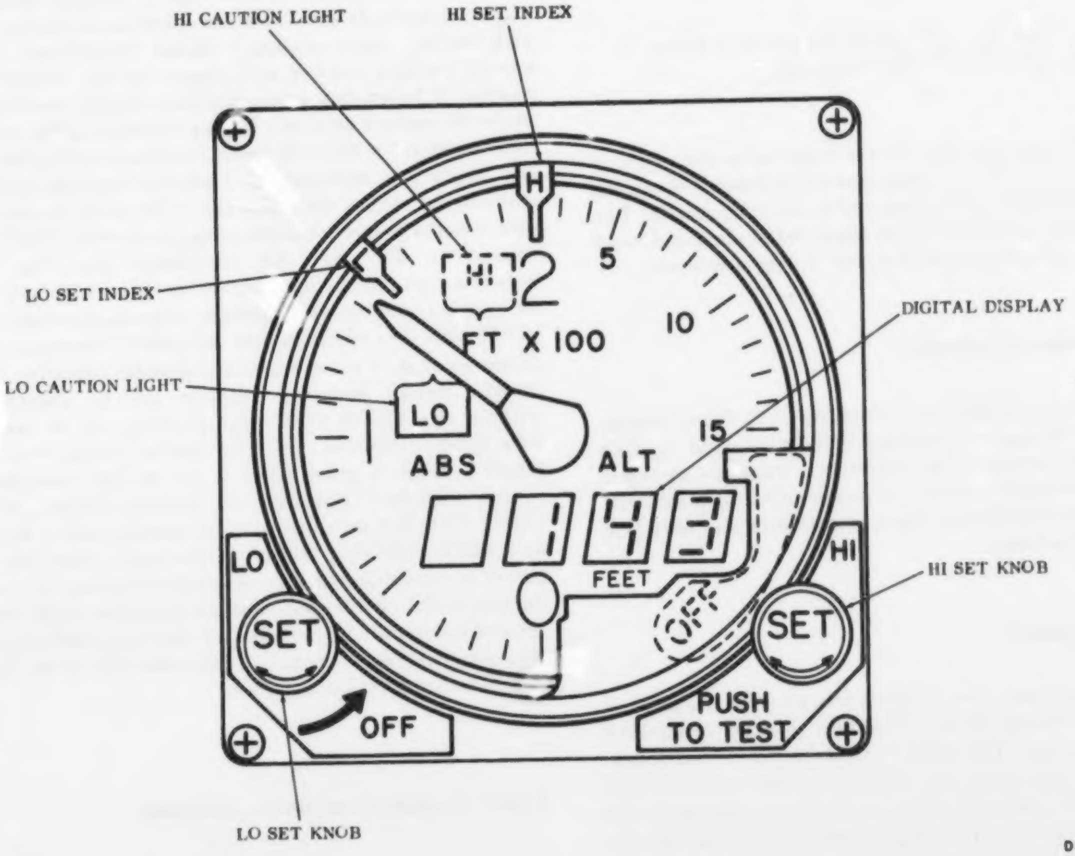


Figure 2-44. Radar Altimeter (AN/APN-209)

lights are set by rotating the LO SET and HI SET knobs until the L index and H index on the perimeter of the altimeter are at the desired altitudes. If the helicopter descends below the low index setting or rises above the high index setting, the corresponding HI or LO caution light will come on. If helicopter altitude exceeds 1,500 feet, pitch or roll angle exceeds 45°, or the system is unreliable, the following will occur. The OFF flag will appear, the pointer will move thru 1,500 feet behind the dial mask, and the digital display and LO and HI caution lights will be out.

If power to the system is lost, the following will occur. The OFF flag will appear, the digital display and caution lights will go out, and the pointer will remain at the last valid indication when power was lost. The altimeters have a self-test feature. Pressing the PUSH-TO-TEST knob will cause the pointer and digital display to indicate between 900 and 1,100 feet. If LO set and HI set are indexed below 900 feet, the LO caution light goes out, and the HI caution light comes on. The radar altimeter receives power from the 28-volt No. 2 dc bus thru RAD ALT circuit breaker on the No. 2 power distribution panel.

2-249. Controls and Function, Radar Altimeter (AN/APN-209A).

CONTROLS/ INDICATOR	FUNCTION
LO SET knob	Either pilot's LO SET knob applies power to altimeter system. LO set index on both altimeters can be set independently. Both LO set indices must be masked to turn the set off.
HI SET knob	Sets position of HI set index and tests altimeter system when pressed.
Lo set index	Indicates altitude trip point for LO caution light.
Hi set index	Indicates altitude trip point for HI caution light
Indicator pointer	Indicates absolute altitude from 0 to 1,500 feet
Digital indicator	Provides direct reading four digit indication of absolute altitude from 0 to 1,500 feet.
LO caution light	Comes on when helicopter descends below altitude on LO set index.
HI caution light	Light comes on when helicopter rises above altitude on HI set index.
OFF flag	Flag is displayed when power is removed from set, when indications are unreliable, or when altitude exceeds approximately 1500 feet.
RAD ALT dimming controls	On right side of both instrument panels. Controls light intensity of digital display and HI and LO caution light.

2-250. Normal Operation — Radar Altimeter (AN/APN-209A).

a. Starting.

(1) RAD ALT circuit breaker — Check in.

(2) Rotate the LO SET knob on the pilot's altimeter until the LO index is at 100 feet. Rotate the HI set knob until the HI index is at 800 feet. Allow 1 minute for warmup.

(3) Check for the following indications:

(a) The pointers indicate between 0 and 3 feet.

(b) The digital displays indicate between 0 and 3 feet.

(c) LO caution light is on.

(d) HI caution light is off.

(e) OFF flag not in view.

b. Testing.

(1) Press and hold the PUSH-TO-TEST knob. Check for the following indications:

(a) OFF flags not in view.

(b) Pointers indicate between 900 feet and 1,100 feet.

(c) Digital displays read between 900 feet and 1,100 feet.

(d) LO caution light is off.

(e) HI caution light is on.

(2) Release the PUSH-TO-TEST knob. Check that all indications return to those specified in step a.3.

(3) Rotate the RAD ALT dimming control from BRT to DIM. Check that the digital display dims and goes out. Check that the LO caution light dims but does not go out completely.

(4) Repeat on copilot's instrument.

NOTE

The LO caution light may appear to go out. However, the light will be visible with night vision goggles. In bright daylight, it may be necessary to shade the indicator to verify operation of the dimming control.

c. Inflight operation.

CAUTION

When operating over dense foilage, the radar altimeters will indicate the altitude to the tops of the trees. When operating over sparse foilage, the altimeters may indicate the altitude between the ground and about half the average tree height, depending on groundspeed. When external cargo is carried, the radar altimeter may occasionally indicate the distance between the bottom of the helicopter and the load.

(1) Set RAD ALT dimming control to desired digital display light level.

(2) Set HI and LO indexes as desired. If HI or LO indexes are not desired, set the LO index at 0 feet or the HI index above 1500 feet.

2-251. Vertical Velocity Indicator.

The vertical velocity indicator (fig. 2-7) on both pilot's and copilot's instrument panel indicates rate of climb, based on the rate of change of atmospheric pressure. The indicator is a direct-reading pressure instrument requiring no electrical power for operation.

2-252. Attitude Indicator.

Two attitude indicators (fig. 2-7) are on the instrument panel for use by the pilot and copilot. The attitude indicators have been specifically tailored for the flight characteristics of a helicopter by the inclusion of an electrical trim capability in the roll axis in addition to the standard pitch trim. (See fig. 2-45.) Normal flight attitudes of helicopters, defined by fixed amounts of roll as well as pitch, are easily trimmed into this indicator, and optimum operation of the helicopter in an attitude such as hover is facilitated. Degrees of pitch and roll are indicated by movement of a universally mounted sphere painted optical black and light gray to symbolize earth and sky, with a horizon line separating the two colors. To adjust the miniature aircraft in relation to pitch, use the lower knob. The pitch adjustment range is about 20° nose up and 20° nose down minimum. To compensate attitude in the roll axis, use the upper knob. The roll adjustment range is about 8° minimum in either direction.

NOTE

Rapid rotation of the pitch and roll trim knobs on the attitude indicator may cause abrupt pitch and roll attitude changes with AFCS on.

The indicator incorporates integral lighting. The attitude indicator gyros receive power from 115-volt No. 1 and No. 2 ac bus thru two circuit breakers marked PILOT VGI and COPLT VGI. The PILOT VGI circuit breaker is on No. 2 power distribution panel. The COPLT VGI circuit breaker is on No. 1 power distribution panel. Both the pilot's and copilot's attitude indicators should erect within 30 to 90 seconds after electrical power is applied.

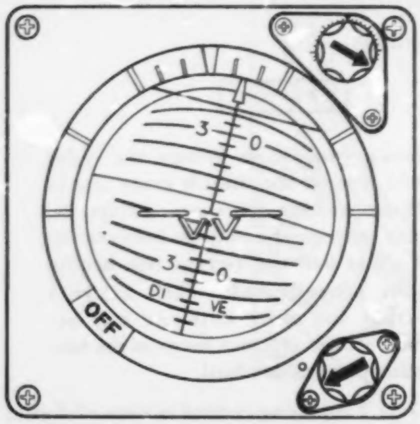


Figure 2-45. Attitude Indicator

2-253. Pilot and Copilot Attitude Indicator (VGI) Switch.

A VGI switch is on the instrument panel below each attitude indicator (fig. 2-7). VGI switch positions are marked NORM and EMER. When the switch is at NORM, each attitude indicator operates from a separate gyro. If either the pilot's or the copilot's gyro fails, signaled by the OFF flag on the indicator, manual switching to the remaining gyro is accomplished by moving the respective VGI switch to EMER. The switching of the gyros from NORM to EMER operation is accomplished by a gyro transfer relay. Failure of the gyro will also result in failure of the associated AFCS. The VGI switch receives power from the 28-volt No. 2 dc bus thru a CONT VGI circuit breaker on No. 2 power distribution panel.

2-254. Turn and Slip Indicator (4-Minute Type).

Each turn and slip indicator (fig. 2-7) is controlled by an electrically actuated gyro. Power for the gyros is obtained from the 28-volt dc bus thru two circuit breakers marked TURN & SLIP. The pilot's circuit breaker is on No. 2 power distribution panel. The copilot's circuit breaker is on No. 1 power distribution panel. The instrument has a pointer (turn indicator) and a ball (slip indicator).

2-255. Magnetic Compass.

The magnetic compass (fig. 2-7) is mounted between the top of the instrument panel glare shield and the overhead switch panel. It is a direct reading instrument requiring no electrical power. It consists of a compass card mounted on a magnetic element in a liquid-filled bowl.

2-256. Free Air Temperature Gage.

The free air temperature gage (fig. 2-5) is on the exterior of the pilot's eyebrow window. The unit is calibrated in degrees from −70° to +50°C.

2-257. Clock.

Interim NVG helicopters are equipped with 2 manually wound 8-day clocks with a sweep second hand, one for the pilot and one for the copilot. NVG helicopters are equipped with two digital clocks (fig. 2-7), one for the pilot and one for the copilot. Each clock has a six-digit GMT display and a four-digit selectable display. There are three controls on each clock, a SELECT button, a CONTROL button, and a DIM switch. The SELECT button allows the selection of any of three modes on the four-digit display: GMT, local time, or elapsed time. The six-digit display shows GMT only. The CONTROL button is used to set the time selected on the four-digit display. When the CONTROL and SELECT buttons are pressed simultaneously, the four-digit display is changed from the normal to the time set mode, and the CONTROL button is functional. The DIM control is used to set the light intensity of the display. At low light settings, the clock display is NVG compatible. The copilot clock receives 28-volt dc from the No. 1 essential bus through a circuit breaker marked CPLT CLOCK on the No. 1 PDP. The pilot clock receives 28-volt dc from the No. 2 essential bus through a circuit breaker marked PLT CLOCK on the No. 2 PDP. Integral alkaline batteries maintain clock operation when no aircraft power is applied, but the CONTROL and SELECT buttons are disabled.

2-258. Master Caution System.

The master caution system (fig. 2-46) provides the pilots with a visual indication of helicopter conditions or faults. The components of the systems are the master caution panel, two master caution lights, two master caution light filters, the master caution test switch, a master caution dimming switch, and a master caution panel NVG filter. Power to operate and control the master caution system is supplied by the 28-volt dc essential bus thru a circuit breaker on the No. 1 power distribution panel labeled CAUTION PNL.

2-259. Master Caution Panel.

The master caution panel (fig. 2-46) is on the center instrument panel. The master caution panel contains 39 capsules. Each capsule is marked with word segments which are related to the fault or condition. Two capsules on each panel are spares. When a caution capsule comes on, the word segments lettered into the panel are an orange color. When they are out, the lettering is not readable. Table 2-2 is a list of the word segments displayed on the capsules and their actual meaning and cause.

2-260. Master Caution Lights.

Two master caution lights on the instrument panel indicate that one or more of the caution capsules have come on (fig. 2-46). On the pilot's panel, the caution light is above the airspeed indicator. On the copilot's panel, it is above the altimeter. Movable NVG filters are attached to the instrument panels to the left of each light. For NVG operations, the filters can be rotated over the two master caution lights making the lights NVG compatible. After

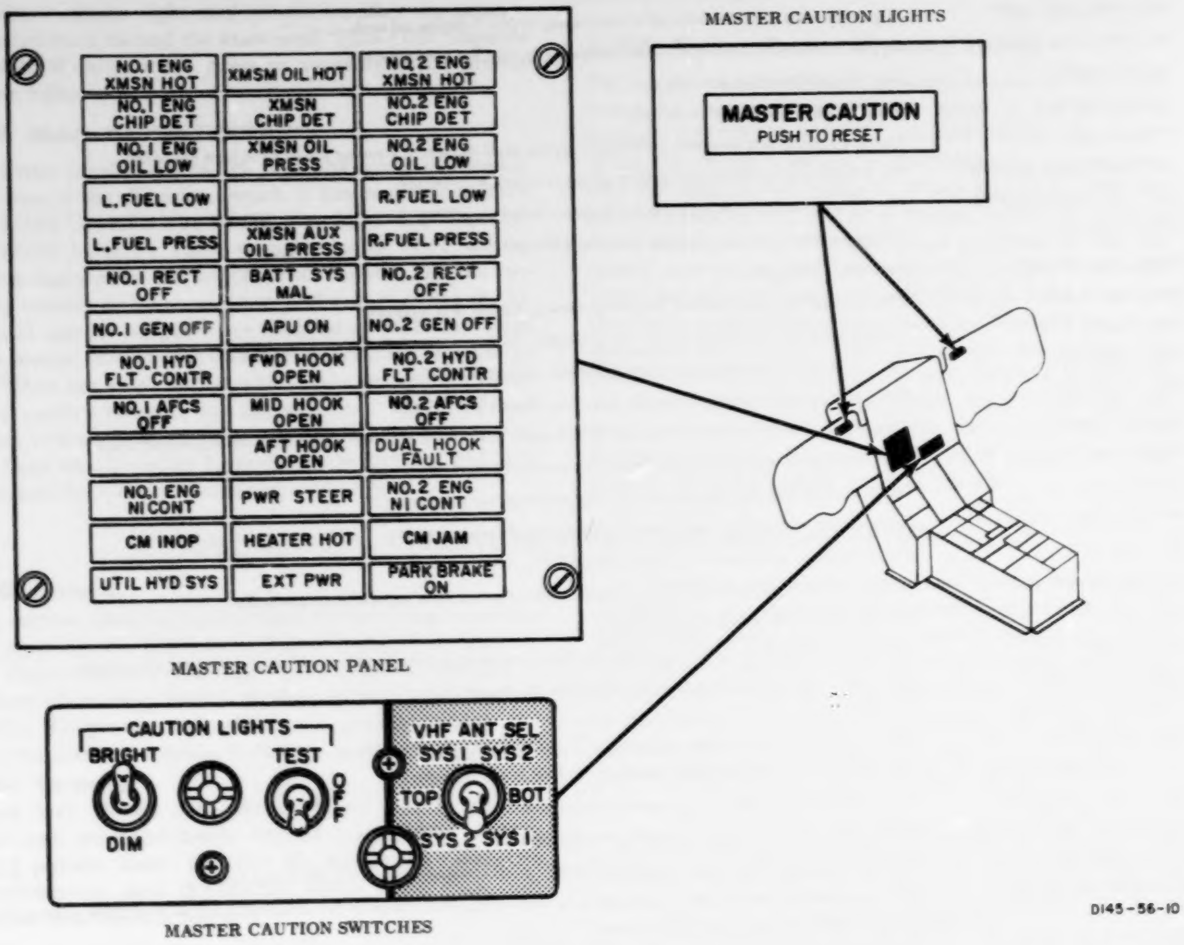

MASTER CAUTION LIGHTS
MASTER CAUTION
PUSH TO RESET
NO. I ENG XMSN HOT
XMSN OIL HOT
NO. 2 ENG XMSN HOT
NO. I ENG CHIP DET
XMSN CHIP DET
NO. 2 ENG CHIP DET
NO. I ENG OIL LOW
XMSN OIL PRESS
NO. 2 ENG OIL LOW
L. FUEL LOW
R. FUEL LOW
L. FUEL PRESS
XMSN AUX OIL PRESS
R. FUEL PRESS
NO. I RECT OFF
BATT SYS MAL
NO. 2 RECT OFF
NO. I GEN OFF
APU ON
NO. 2 GEN OFF
NO. I HYD FLT CONTR
FWD HOOK OPEN
NO. 2 HYD FLT CONTR
NO. I AFCS OFF
MID HOOK OPEN
NO. 2 AFCS OFF
AFT HOOK OPEN
DUAL HOOK FAULT
NO. I ENG NI CONT
PWR STEER
NO. 2 ENG NI CONT
CM INOP
HEATER HOT
CM JAM
UTIL HYD SYS
EXT PWR
PARK BRAKE ON
MASTER CAUTION PANEL
CAUTION LIGHTS
BRIGHT
DIM
TEST
OFF
VHF ANT SEL
SYS I
SYS 2
TOP
BOT
SYS 2
SYS I
MASTER CAUTION SWITCHES
D145-56-10

Figure 2-46. Master Caution System

Table 2-2. Master Caution Panel Capsules

WORD SEGMENT	EXPLANATION
XMSN OIL HOT	Transmission oil temperature is more than 140°C.
XMSN OIL PRESS	Transmission main oil pressure is less than 20 psi, or less than 10 psi in the aft rotor shaft.
XMSN AUX OIL PRESS	Less than 20 psi auxiliary oil pressure in the forward, or aft transmission or less than 10 psi in the combining transmission.
NO. 1 ENG OIL LOW	Approximately 2 qt of usable oil is remaining in No. 1 engine oil tank.
NO. 2 ENG OIL LOW	Approximately 2 qt of usable oil is remaining in No. 2 engine oil tank.
L FUEL PRESS	Left fuel pressure is below 10 psi.
R FUEL PRESS	Right fuel pressure is below 10 psi.
PWR STEER	Steering control has been disabled due to system malfunction or steering limits have been exceeded.
NO. 1 HYD FLT CONTR	No. 1 flight control hydraulic system pressure is below 2,000 psi.
NO. 2 HYD FLT CONTR	No. 2 flight control hydraulic system pressure is below 2,000 psi.
UTIL HYD SYS	Utility hydraulic system pressure is below 2,000 psi.
PARK BRAKE ON	Parking brake is on.
NO. 1 RECT OFF	Transformer-rectifier has failed or the generator output is interrupted.
NO. 2 RECT OFF	Transformer-rectifier has failed or the generator output is interrupted.
NO. 1 GEN OFF	No. 1 generator is inoperative or the generator switch is at OFF.
NO. 2 GEN OFF	No. 2 generator is inoperative or the generator switch is at OFF.
BATT SYS MAL	Battery or battery charging system has failed or the battery has exceeded the safe operating temperature.
EXT PWR	This light comes on whenever ac external power is connected.
L FUEL LOW	Left main fuel tank has approximately 20 percent of fuel remaining.
R FUEL LOW	Right main fuel tank has approxiately 20 percent of fuel remaining.
HEATER HOT	Temperature within heater is greater than 177°C.
MID HOOK OPEN	The midcargo hook has been opened, either hydraulically, pneumatically, or manually.
APU ON	The apu is up to speed and can be used.
DUAL HOOK FAULT	The forward and or aft hook circuit has an electrical fault and the hook(s) shall not be released electrically.
FWD HOOK OPEN AFT HOOK OPEN	The indicated hook has been opened either electrically or manually.
NO. 1 AFCS OFF	The No. 1 AFCS is off, malfunctioning, or DASH is reprogramming.
NO. 2 AFCS OFF	The No. 2 AFCS is off, malfunctioning, or DASH is reprogramming.
NO. 1 ENG CHIP DET	Metal chips in No. 1 engine or engine transmission oil.
NO. 2 ENG CHIP DET	Metal chips in No. 2 engine or engine transmission oil.
XMSN CHIP DET	Metal chips in the oil of the forward, combining, or aft transmissions or the aft thrust bearing.
NO. 1 ENG N1 CONT	No. 1 engine N1 control loop is energized, or engine condition lever or N1 actuator is not in the STOP, GROUND or FLIGHT position.
NO. 2 ENG N1 CONT	No. 2 engine N1 control loop is energized, or engine condition lever or N1 actuator is not in the STOP, GROUND or FLIGHT position.
NO. 1 ENG XMSN HOT	No. 1 engine transmission oil temperature is above about 190°C.
NO. 2 ENG XMSN HOT	No. 2 engine transmission oil temperature is above about 190°C.
CM INOP	Countermeasures set has failed.
CM JAM	Countermeasures set has detected interference from other countermeasures sets or system is being jammed.

the master caution (MASTER CAUTION) light has come on and the condition noted, the pilots should extinguish the master caution light by pressing (PUSH TO RESET) the face of the light. The master caution light is then ready to indicate a subsequent malfunction of a different system. Once the malfunction is corrrected, the affected caution capsule will go out. The HEATER HOT capsule is an exception. (Refer to para 2-183.) If either generator is cycled OFF then ON while another caution capsule is lit, the master caution light may remain on after the generator comes back on and the associated "GEN OFF" capsule goes out. If this occurs, press to extinguish the master caution light.

2-261. Master Caution Test Switch.

The master caution test switch is on the center instrument panel next to the dimming switch. It has positions marked CAUTION LIGHTS TEST-OFF. (See fig. 2-46.) When the CAUTION LIGHTS TEST switch is set to TEST, all the caution capsules on the master caution panel and the two master caution lights come on to facilitate checking the individual capsule lamps. When released to OFF, the lamps in the master caution lights and all the caution capsules go out. When the pilot and copilot flight instrument lights rotary control switches are on, and the VHF NAV and marker beacon VOL switches are on, the test feature will also light all the select legends on the MODE SELECT panel, and the marker beacon indicator lights.

2-261.1. Master Caution Panel NVG Filter.

A master caution panel NVG filter is provided for use during NVG operations. The filter fits over the master caution panel and is secured in place by hook and pile tape at its base. When the filter is in this position, any light coming from the caution lights will be NVG compatible. For normal operations the filter is rotated from its base to a horizontal position, and stowed in a compartment above the master caution panel.

2-262. Master Caution Dimming Switch.

The master caution dimming switch is next to the TEST switch on the center instrument panel. It has positions marked CAUTION LIGHTS BRIGHT-DIM (fig. 2-46). When the switch is moved to BRIGHT, the caution capsule will light to full intensity. When moved to DIM the caution capsules will not be as bright. When the cockpit dome lights are on white, it is not possible to dim the master caution panel. If the white dome light is selected while the caution lights are operating on DIM, the caution lights will automatically switch to BRIGHT mode of operation. On interim NVG helicopters this switch also controls the lighting intensity of both TROOP JUMP LTS on the overhead panel, the DPLR NAV keyboard, the missle detector STBY legend, the flare dispenser ARM indicator, and the SEL and VOR/ADF pushbutton legends on both HSI MOD SELECT panels.

SECTION XV SERVICING, PARKING, AND MOORING

2-263. General.

This section contains instructions on servicing, parking, and mooring the helicopter. These instructions include only those tasks which a flight crew may be expected to perform when away from a military maintenance support activity. Diagrams and tables are provided depicting servicing points, materials, walkways, and mooring points.

2-264. Servicing.

Figure 2-47 shows the safe walkway areas, no step areas, and no hand holds. Figure 2-48 shows the servicing points. Table 2-3 lists the approved materials, specifications, and capacities. Table 2-3.1 lists commercial equivalents for oils.

2-265. Fuel Types.

The following describe the various types of fuels:

a. Army standard fuels. JP-4 is the Army-designated primary fuels adopted for worldwide use.

b. Alternate fuels. These are JP-5, JP-8, and equivalent commercial fuels which can be used continuously without power reduction when Army standard fuel is not available. Power setting adjustments and increased maintenance may be required when an alternate fuel is used.

c. Emergency Fuels. 100LL (Low Lead) AVGAS is authorized for use as an emergency fuel with operation not to exceed 6 hours cumulative time. All engine operation using emergency fuels shall be recorded on DA Form 2408-13.

2-266. Use of Fuels.

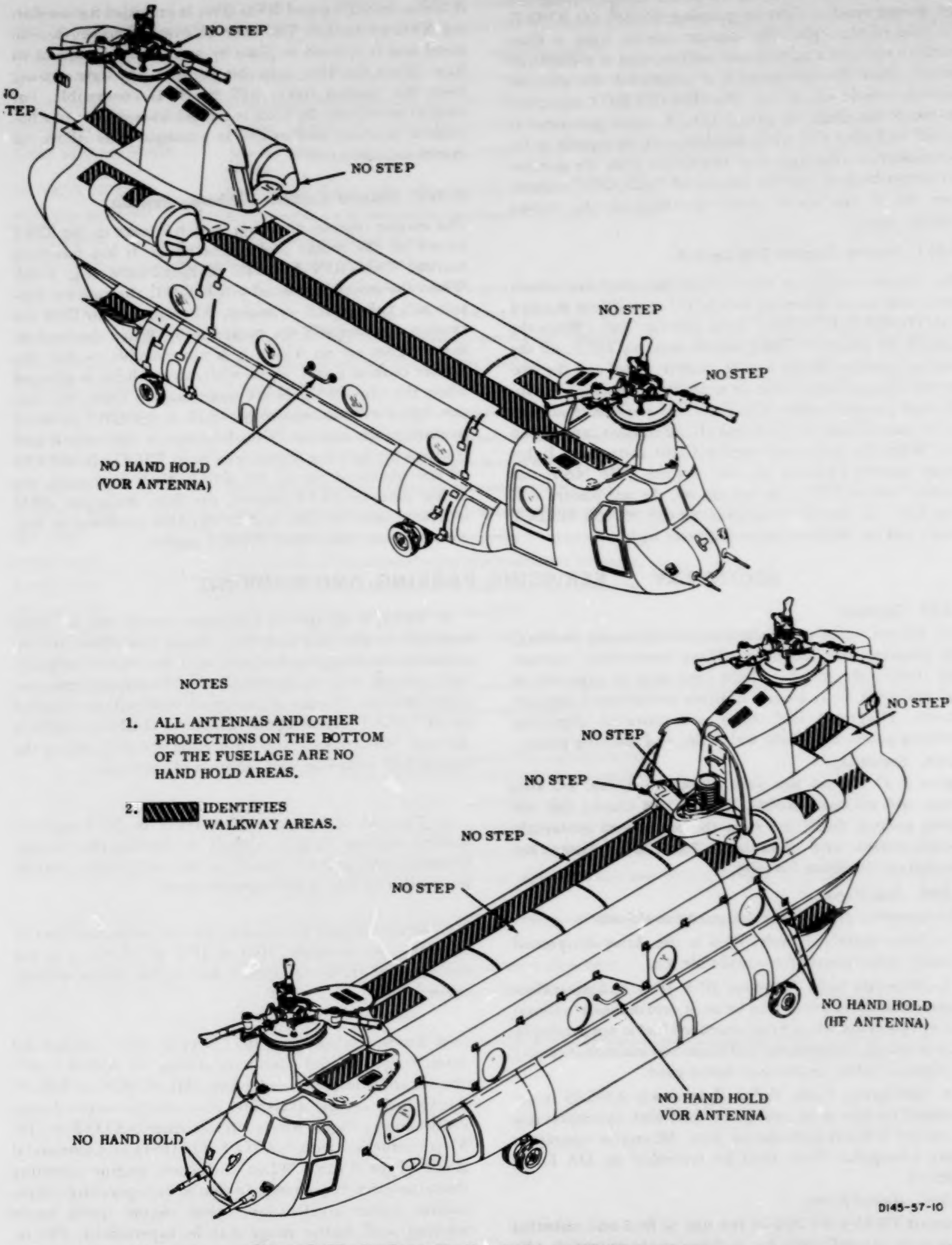
Consult TB 55-9150-200-24 for use of fuel and substitution data as applicable for turbine engine aircraft. (Refer to tables 2-3, 2-4, and 2-5.)

a. There is no special limitation on the use of Army standard or alternate fuel. But, certain limitations are imposed when emergency fuels are used. For record purposes, fuel mixtures shall be identified as to the major component of the mixture. The use of emergency fuels will be recorded in the FAULTS/REMARKS column of DA Form 2408-13, Aircraft Maintenance and Inspection Record, noting the type of fuel, additives, and duration of operation.

b. The use of kerosene fuels (JP-5 or JP-8 type) in turbine engines dictates a need for special precautions. Ground starts and air restarts at low temperature may be more difficult due to low vapor pressure.

c. When changing from one type of authorized fuel to another — for example, JP-4 to JP-5 or JP-8 — it is not necessary to drain the aircraft fuel system before adding the new fuel.

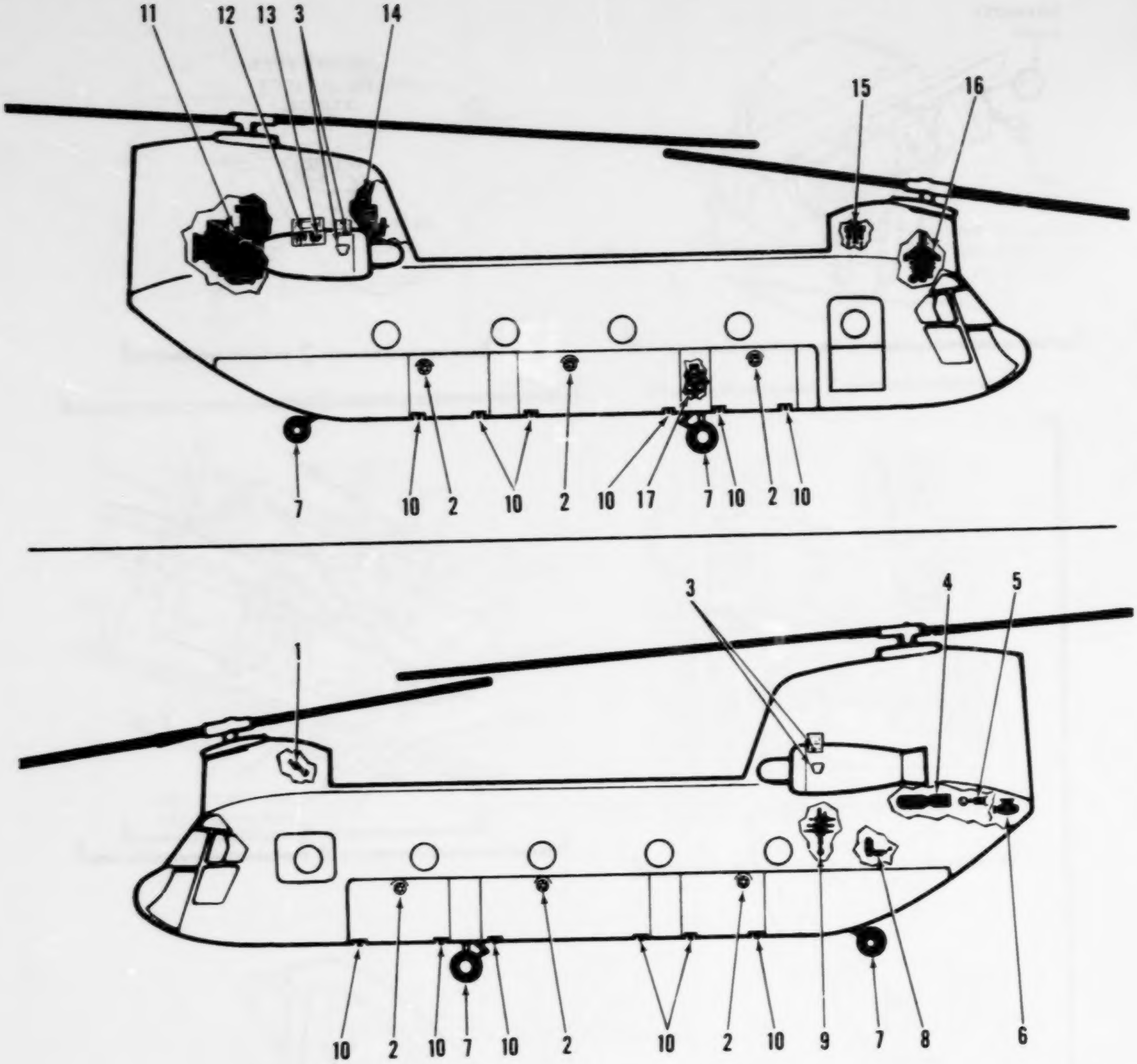
d. Fuels having the same NATO code number are interchangeable. Jet fuels conforming to ASTM-3-1655 specification may be used when MIL-T-5624 or MIL-T-83133 fuels are not available. This usually occurs during cross-country flights where aircraft using NATO F-44 (JP-5) are refuelled with NATO F-40 (JP-4) or Commercial ASTM Type B fuels. When this occurs, engine operating characteristics may change in that lower operating temperature, slower acceleration, lower engine speed, easier starting, and shorter range may be experienced. The reverse is true when changing from F-40 (JP-4) fuel to F-44 (JP-5) or Commercial ASTM Type A-1 fuels.


NO STEP
IO
TEP
NO STEP
NO STEP
NO STEP
NO HAND HOLD
(VOR ANTENNA)
NO STEP
NO STEP
NO STEP
NO STEP
NO STEP
NO HAND HOLD
(HF ANTENNA)
NO HAND HOLD
VOR ANTENNA
NO HAND HOLD
D145-57-10

NOTES

1. ALL ANTENNAS AND OTHER PROJECTIONS ON THE BOTTOM OF THE FUSELAGE ARE NO HAND HOLD AREAS.
2. ▨ IDENTIFIES WALKWAY AREAS.

Figure 2-47. No Step, No Handhold, and Walkway Areas



1. BRAKE ACCUMULATOR
2. GRAVITY FUEL FILLER
3. ENGINE OIL LEVEL INDICATOR AND FILLER
4. APU START ACCUMULATOR
5. SIGNAL ACCUMULATOR
6. APU
7. TIRE
8. HYDRAULIC SYSTEMS FILL MODULE
9. POWER STEERING AND SWIVEL LOCK ACCUMULATOR
10. FUEL TANK DRAIN VALVE
11. AFT TRANSMISSION
12. NO. 2 FLIGHT CONTROL SYSTEMS ACCUMULATOR
13. UTILITY RESERVOIR PRESSURIZATION ACCUMULATOR
14. ENGINE AND COMBINING TRANSMISSION OIL LEVEL INDICATOR AND FILLER
15. NO. 1 FLIGHT CONTROL SYSTEM ACCUMULATOR
16. FORWARD TRANSMISSION OIL LEVEL INDICATOR AND FILLER
17. PRESSURE REFUELING SYSTEM FILLER AND CONTROL PANEL

D145-58-10 (1)

Figure 2-48. Servicing Diagram (Sheet 1 of 4)

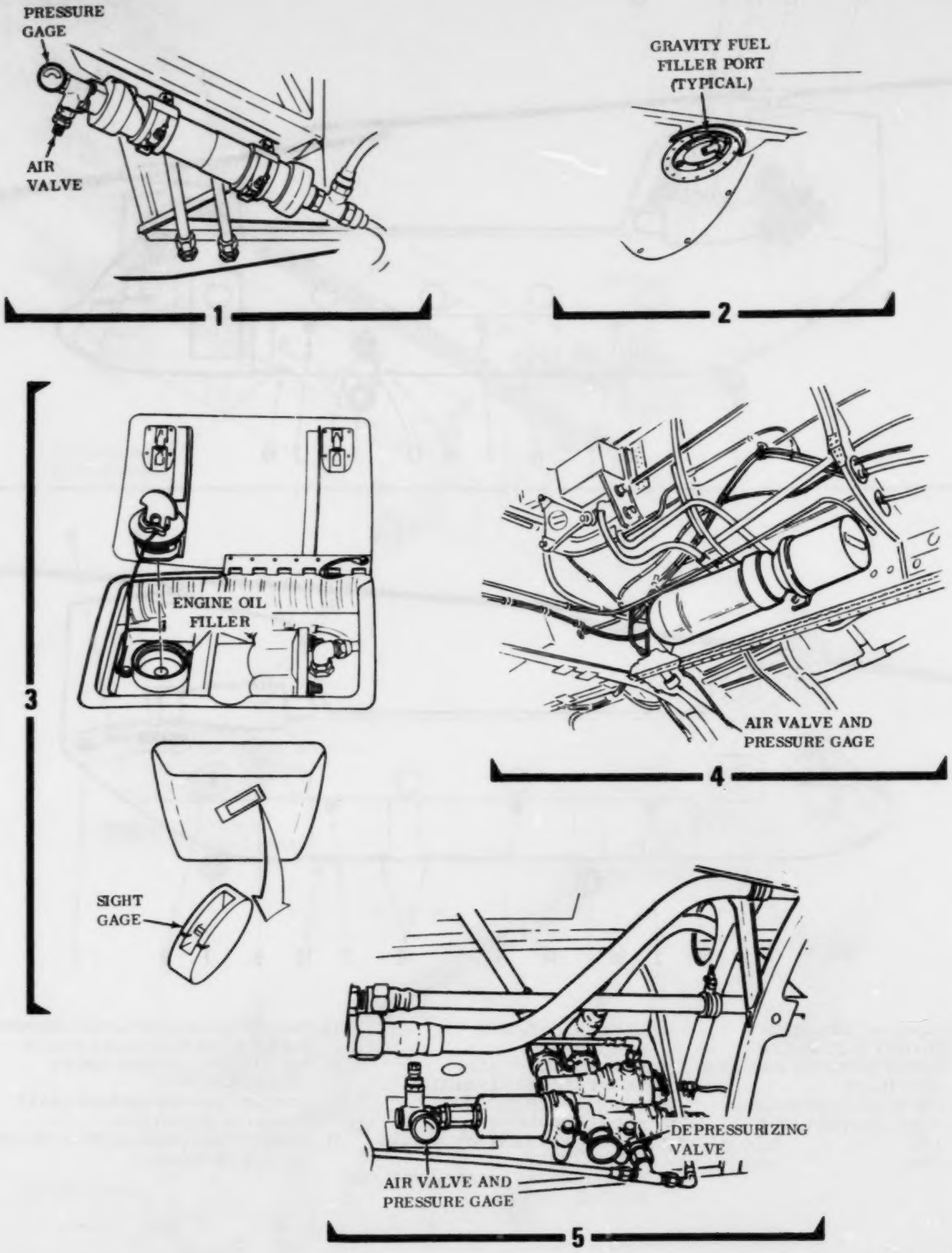
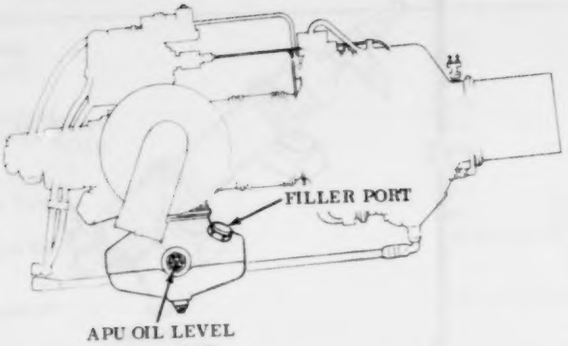
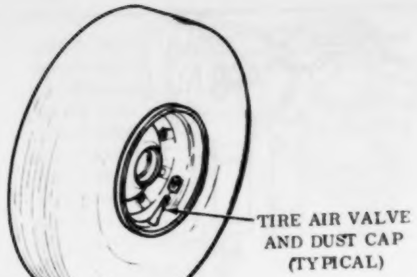

PRESSURE GAGE
AIR VALVE
1
GRAVITY FUEL FILLER PORT (TYPICAL)
2
ENGINE OIL FILLER
SIGHT GAGE
3
AIR VALVE AND PRESSURE GAGE
4
DEPRESSURIZING VALVE
AIR VALVE AND PRESSURE GAGE
5
D145-58-10(2)

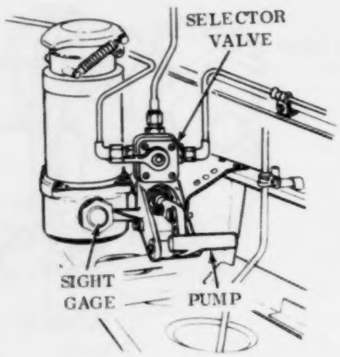
Figure 2-48. Servicing Diagram (Sheet 2 of 4)


FILLER PORT
APU OIL LEVEL SIGHT GAGE

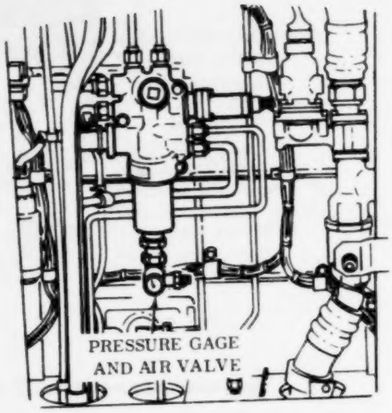
6


TIRE AIR VALVE AND DUST CAP (TYPICAL)

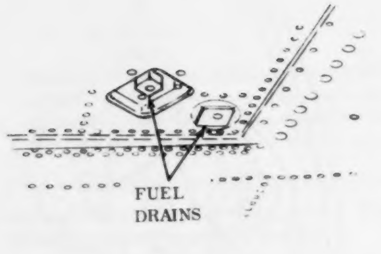
7


SELECTOR VALVE
SIGHT GAGE
PUMP

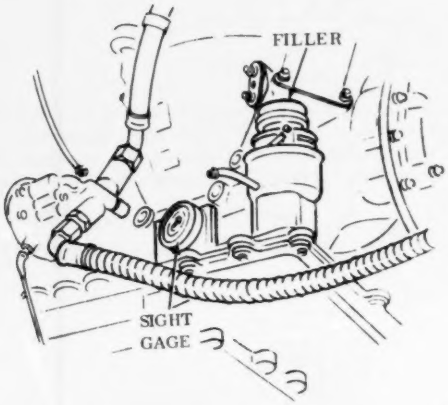
8


PRESSURE GAGE AND AIR VALVE

9


FUEL DRAINS

10


FILLER
SIGHT GAGE

11

D145-58-10(3)

Figure 2-48. Servicing Diagram (Sheet 3 of 4)

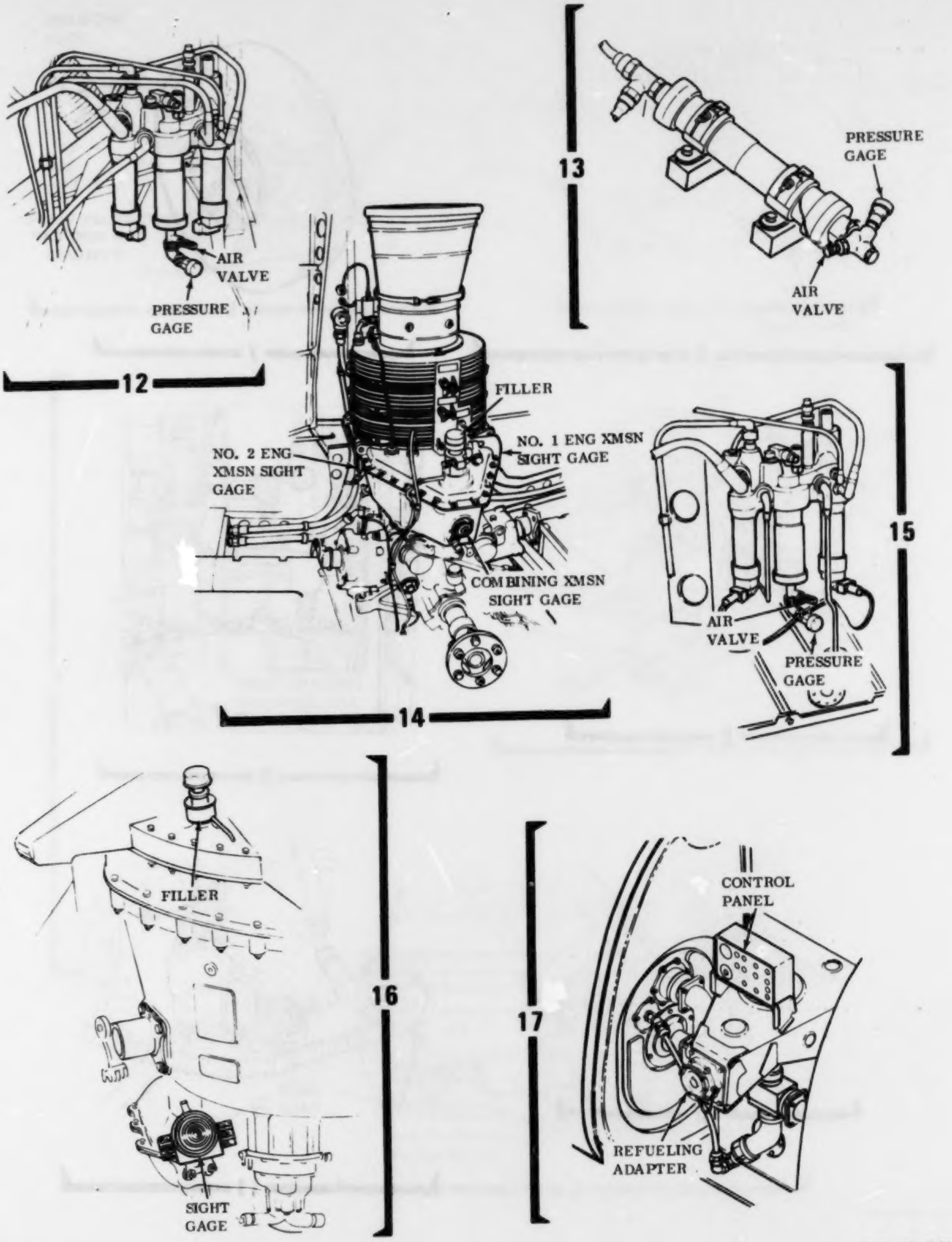

12
AIR VALVE
PRESSURE GAGE
13
PRESSURE GAGE
AIR VALVE
14
FILLER
NO. 1 ENG XMSN SIGHT GAGE
NO. 2 ENG XMSN SIGHT GAGE
COMBINING XMSN SIGHT GAGE
15
AIR VALVE
PRESSURE GAGE
16
FILLER
SIGHT GAGE
17
CONTROL PANEL
REFUELING ADAPTER
D145-58-10 (4)

Figure 2-48. Servicing Diagram (Sheet 4 of 4)

Table 2-3. Servicing

SERVICEABLE ITEM	MATERIAL	SPECIFICATION	CAPACITY (APPROX)
L Main Tank **R Main Tank**	JP-4 JP-5 JP-8	MIL-T-5624 MIL-T-5624 MIL-T-83133	278 Gallons 274 Gallons
L Fwd Aux Tank **R Fwd Aux Tank**	JP-4 JP-5 JP-8	MIL-T-5624 MIL-T-5624 MIL-T-83133	122 Gallons 119 Gallons
L Aft Aux Tank **R Aft Aux Tank**	JP-4 JP-5 JP-8	MIL-T-5624 MIL-T-5624 MIL-T-83133	118 Gallons 117 Gallons
Each Engine Oil Tank	Lubrication Oil	MIL-L-23699 (See note C) or MIL-L-7808	4 Gallons
APU Engine Oil	Lubrication Oil	MIL-L-7808 or MIL-L-23699 (See note C)	3 Quarts
Forward Transmission	Lubrication Oil	MIL-L-7808 or MIL-L-23699 (See note C)	26 Quarts
Aft Transmission	Lubrication Oil	MIL-L-7808 or MIL-L-23699 (See note C)	41 Quarts
Combining Transmission	Lubrication Oil	MIL-L-7808 or MIL-L-23699 (See note C)	20 Quarts
Engine Transmissions (each)	Lubrication Oil	MIL-L-7808 or MIL-L-23699 (See note C)	10 Quarts
Each Flight Control System Reservoir	Hydraulic Fluid	MIL-H-83282 (See note B)	2 Quarts
Utility Hydraulic System Reservoir	Hydraulic Fluid	MIL-H-83282 (See note B)	6 Quarts
Rotor Head Oil Tanks	Lubrication Oil	MIL-L-7808	As Required
Shock Absorbers and Landing Gear Shock Struts	Hydraulic Fluid	MIL-H-5606	As Required
Swashplates	Grease	MIL-G-81322	As Required
Tires — 8.50 x 10 Type III, Forward and Aft	Air/Nitrogen		88 PSI
Accumulators **Apu Start** **Brakes** **Power Steering/Swivel Lock** **Signal Accumulator** **Utility Reservoir** **No. 1 and No. 2 Flight Control**	Air/Nitrogen	BB-N-411	

WARNING

Synthetic oils, such as MIL-L-23699 and MIL-L-7808, may soften paint or stain clothing upon contact. If synthetic oil is spilled on painted surfaces, those surfaces should be cleaned immediately. Skin should be thoroughly washed after contact and saturated clothing should be removed immediately. Prolonged skin contact with synthetic oils may cause a skin rash. Areas where synthetic oils are used should have adequate ventilation to keep mist and fumes to a minimum.

NOTES:

A. These are maximum capacities which include residual and trapped oil. Servicing capacities will be less.

B. Hydraulic fluid MIL-H-5606 may be used. When MIL-H-83282 is not available, an entry in the Remarks Section of DA Form 2408-13 indicating quantity added is required.

C. When free air temperature is below −32°C, use MIL-L-7808.

Table 2-3.1. Equivalent Oils and Hydraulic Fluids

APPROVED DOMESTIC COMMERCIAL OILS FOR MIL-L-23699

Manufacturer's Designation:

- PQ Turbine Lubricant 6423/6700/3889/3893/C3788/9598
- Brayco 899/899-G
- Castrol 5000
- EMGARD Synthesised Turbine Lubricant 2592/2949
- EXXON 2380
- ESSO Turbo Oil 2830
- HATCOL 3211/3611/1639/1680
- Mobile RM-139A/147A/247A/246A/249A/250A/270A
- Royco 899/899B/899C/899HC/899E-1/899E-2
- Aeroshell Turbine Oil 500
- Stauffer Jet II E-7603

APPROVED DOMESTIC COMMERCIAL FLUIDS FOR MIL-H-5606

Manufacturer's Designation:

- PQ 2890/2863/2903/2905/2950/4140/3808/4328
- Mobile Aero HFD
- Stauffer Aero Hydroil 500
- Brayco 757B/756F/756ES/756E
- Brayco Micronic 756ES
- TEXACO Aircraft Hydraulic Oil 15/TL-10711
- Chevron Aviation Hydraulic Fluid D PED 5225
- Penreco Petrofluid 4606/4146/4607
- Royco 756C/756D/756E
- Castrol Hyspin A
- Aeroshell Fluid 41

APPROVED DOMESTIC COMMERCIAL FLUIDS FOR MIL-H-83282

Manufacturer's Designation:

- Royco 782 E-1/782 E-2
- Gulf TS-741
- Brayco Micronic 882/882A
- Royco 782/782-1/782-2
- Aeroshell Fluid 31
- American Oil PQ3883/4219/4401B/4627/4268/4362C/4401/4401A/4923/4908
- Emery 2946A/2942/2857/2858
- HATCOL 4283/4284/4285
- Penreco Petrofluid 822

APPROVED DOMESTIC COMMERCIAL OILS FOR MIL-L-7808

Manufacturer's Designation:

- AeroShell Turbine Oil 308
- American Oil PQ Turbine Oil 8365/9900/4236
- Castrol 399
- Brayco 880
- EXXON Turbo Oil 2389/2391
- HATCO 1278/1280
- Mobil RM-272A/248A
- Royco 808H/808HC
- AeroShell Turbine Oil 308
- Technolube SYN TURBO No. 3

Table 2-4. JP-4 Equivalent Fuel

JP-4 EQUIVALENT FUELS

MILITARY FUEL

U.S.	JP-4 (MIL-T-5624)
NATO	F-40 (Wide cut type)

COMMERCIAL FUEL (ASTM-D-1655) JET B*

American Oil Co.	American JP-4
Atlantic Richfield, Richfield Div.	Arcojet B
B.P. Trading	B.P.A.T.G.
Caltex Petroleum Corp.	Caltex Jet B
Chevron	Chevron B
Continental Oil Co.	Conoco JP-4
EXXON Co., USA	EXXON Turbo Fuel B
Gulf Oil	Gulf Jet B
Mobil Oil	Mobil Jet B
Phillips Petroleum	Philjet JP-4
Shell Oil	Aeroshell JP-4
Texaco	Texaco Avjet B
Union Oil	Union JP-4

FOREIGN FUEL (F-40)

Belgium	BA-PF-2B
Canada	3GP-22F
Denmark	JP-4 MIL-T-5624
France	Air 3407 A
Germany (West)	VTL 9130-006
Greece	JP-4 MIL-T-5624
Italy	AA-M-C-1421
Netherlands	JP-4MIL-T-5624
Norway	JP-4MIL-T-5624
Portugal	JP-4MIL-T-5624
Turkey	JP-4MIL-T-5624
United Kingdom (Britain)	D. Eng RD 2454

***Commercial fuel such as ASTM-D-1655 not containing an icing inhibitor per MIL-I-27686 (commercial name is "PRIST"). Use PRIST in accordance with instructions on the can. Anti-icing and Biocidal Additive for Commercial Turbine Engine Fuel — The fuel system icing inhibitor shall conform to MIL-I-27686. The additive provides anti-icing protection and also functions as a biocide to kill microbial growths in helicopter fuel systems. Icing inhibitor conforming to MIL-I-27686 shall be added to commercial fuel not containing an icing inhibitor during refueling operations, regardless of ambient temperatures. Refueling operations shall be accomplished in accordance with accepted commercial procedures. Commercial product PRIST conforms to MIL-I-27686.**

Table 2-5. JP-5 and JP-8 Equivalent Fuel

JP-5 and JP-8 EQUIVALENT FUELS

MILITARY FUEL

U.S.	JP-5 (MIL-T-5624)	JP-8 (MIL-T-83133)
NATO	F-44	F-34

COMMERCIAL FUELS (ASTM-D-1655) JET A/JET A-1*

American Oil Co.	American type A	
Atlantic Richfield	ArcoJet A	Arcojet A-1
Richfield Div.	Richfield A	Richfield A-1
B.P. Trading		B.P.A.T.K.
Caltex Petroleum Corp.		Caltex Jet A-1
Chevron	Chevron A-50	Chevron A-1
Cities Service Co.	CITGO A	
Continental Oil Co.	Conoco Jet-50	Conoco Jet-60
EXXON Co., USA	EXXON A	EXXON A-1
Gulf Oil	Gulf Jet A	Gulf Jet A-1
Mobil Oil	Mobil Jet A	Mobil Jet A-1
Phillips Petroleum	Philjet A-50	
Shell Oil	Aeroshell 640	Aeroshell 650
Sinclair	Superjet A	Superjet A-1
Standard Oil Co.	Jet A Kerosene	Jet A-1 Kerosene
Texaco	AVjet A	Avjet A-1
Union Oil	76 Turbine Fuel	

Table 2-5. JP-5 and JP-8 Equivalent Fuel (Continued)

	FOREIGN FUELS (NATO F-44)
Canada	3-GP-24e
West Germany	UTL-9130-007/UTL-9130-010
Italy	AMC-143
Netherlands	D. Eng RD 2493
United Kingdom (Britain)	D. Eng. RD 2498

***Commercial fuel such as ASTM-D-1655 not containing an icing inhibitor per MIL-I-27686 (commercial name is "PRIST"). Use PRIST in accordance with instructions on the can. Anti-icing and Biocidal Additive for Commercial Turbine Engine Fuel — The fuel system icing inhibitor shall conform to MIL-I-27686. The additive provides anti-icing protection and also functions as a biocide to kill microbial growths in helicopter fuel systems. Icing inhibitor conforming to MIL-I-27686 shall be added to commercial fuel not containing an icing inhibitor during refueling operations, regardless of ambient temperatures. Refueling operations shall be accomplished in accordance with accepted commercial procedures. Commercial product PRIST conforms to MIL-I-27686.**

WARNING

To prevent fuel spilling from the tanks, do not open any gravity filling cap after pressure refueling.

The CH-47D helicopter has six fuel tanks, three tanks on each side. The tanks can be serviced thru the single-point pressure refueling system or thru filler ports in each tank. The single-point method of servicing is preferred. Using this method, all tanks can be filled, partially filled, or selectively filled in less than 4 minutes. Refer to table 2-3 for individual tank capacities.

2-268. Single-Point Pressure Refueling.

The pressure refueling control panel and nozzle receptacle are on the right side of the helicopter above the forward landing gear. (See fig. 2-20.) The landing gear access cover must be opened to expose the panel and receptacle. A nozzle grounding adapter is located on the structure adjacent to the receptacle.

a. Be sure the helicopter is at least 50 feet from any hangar or structure.

b. Be sure the refueling unit is at least 10 feet from the helicopter.

c. Electrically ground the helicopter and refueling unit as follows:

(1) Connect one end of ground cable to the aft landing gear eyebolt or to the jack on the right side of the fuselage at sta 115. Connect the other end to a grounding rod or ramp ground point. Be sure the cable has no broken strands and the clips are securely attached to the cable and ground points.

(2) Be sure the fueling unit is grounded to the same ground point as the helicopter.

d. At the cockpit overhead fuel panel, set REFUEL STATION switch to ON.

CAUTION

Be sure the fueling station fuel quantity indicator is operating before pressure fueling. If the indicator is not operating, the fuel shutoff valves cannot be checked properly and fuel cell overpressurization may result.

e. Open the right forward landing gear access panel and perform the following check:

(1) Set the PWR switch to ON. Check that both REFUEL VALVE POSN lights momentarily come ON, then go off. If either light comes on and does not go out, the associated refueling valve has failed and fuel will not flow into that aft tank. If the fuel in this tank is required to complete the mission, notify maintenance.

(2) If required, set the LIGHT switch to ON.

(3) Set the FUEL QTY SEL switch to TOTAL.

(4) Set the ALL TEST switch to PRI OFF.

(5) Connect the grounding wire to the grounding receptacle and connect the fueling nozzle to the adapter.

CAUTION

If either the primary or secondary float switch for any tank is inoperative, do not pressure refuel that tank unless the fuel cap is removed to prevent possible fuel cell overpressurization. If both switches are inoperative, do not pressure refuel that tank. In addition, if both float switches are inoperative for either main tank, the system must be repaired prior to flight to prevent fuel cell overpressure.

(6) Open the flow control valve on the nozzle. Check that fuel flow stops within 4 seconds.

(7) Set the ALL TEST switch to SEC OFF. Check that fuel flow stops within 4 seconds.

f. If all tanks are to be filled, set the ALL TEST switch to FLOW. All tanks will now fill independently. Shutoff valves in each tank will close and stop fuel flow as each tank fills.

g. When refueling is complete, close the flow control valve.

h. If tanks are to be partially or selectively filled, be sure to perform steps e.6 and e.7, then proceed as follows:

(1) Set the six FUEL CELL SHUTOFF VALVE test switches to PRI OFF.

(2) Set the ALL TEST switch to FLOW.

(3) Rotate the FUEL QTY SEL switch to the tank to be filled. The indicator pointer will indicate tank fuel quantity.

(4) Set the FUEL CELL SHUTOFF VALVE TEST switch of the tank to be filled to flow.

(5) Open the flow control valve.

(6) When the desired fuel level is reached, set the fuel cell shutoff valve test switch to PRI OFF.

(7) Repeat steps 3, 4, and 6 on each tank until the desired amount of fuel is in each tank.

(8) Close the flow control valve and disconnect the nozzle and ground cable.

i. Set the PWR switch to OFF. Check that the REFUEL VALVE POSN lights come on momentarily, then go out. If either light does not come on, then go out, the fuel in that aft tank is unusable. Notify maintenance.

j. Close the landing gear access door.

k. Remove ground cables from the helicopter.

l. Set the REFUEL STATION switch on the overhead panel to OFF.

CAUTION

Perform steps m. n. and o. if helicopter will not be operated immediately. Failure to do so could result in refuel manifold seepage caused by fuel expansion.

m. Start the APU and turn APU GEN switch to ON, or apply AC external power.

n. Operate the forward fuel boost pump in each main fuel tank for at least one minute.

o. Stop the APU, or disconnect the external power.

2-269. Gravity Refueling.

a. Be sure the helicopter is at least 50 feet from any hangar or structure.

b. Be sure the fueling vehicle is at least 10 feet from the helicopter.

c. Electrically ground the helicopter as follows:

(1) Connect one end of an approved ground cable to the aft landing gear eyebolt or to one of the jacks on the side of the fuselage. Grounding jacks are located at sta 115 on the RH side and sta 530 on the LH side in the fuselage skin. Connect the other end to a grounding rod or ramp ground point. Make sure the cable has no broken strands and the clips are securely attached to the cable and ground points.

(2) Make sure the fueling unit is grounded to the same ground rod or ground point as the helicopter.

(3) Prior to opening the filler cap, ground the nozzle to the ground jack directly above the fuel tank filler. When finished fueling the tank, close and secure the filler cap before disconnecting the nozzle ground.

d. When the fuel is at the desired level, remove the nozzle. Secure the filler cap. Then, disconnect the nozzle ground wire.

e. Remove the ground connection. If the helicopter is to remain parked, do not disconnect the helicopter ground.

2-270. Engine Oil System.

The engine oil tank and oil quantity indicator (fig. 2-48) are an integral part of the engine. Service either engine oil system as follows:

a. If the engine has not been operated in the preceding 30 minutes and the oil level is low, run it and then recheck the oil level. Otherwise, an inaccurate oil level may be indicated.

b. Open the access panel of the forward left side of the engine cover. Check oil level on indicator.

c. If the indicator shows less than full, open the oil filler access panel on the forward top side of the engine cover.

d. Refer to DA Form 2408-13 and table 2-2 for the type of oil to use. Under normal conditions, engines shall be serviced with one type of oil only. If one type of oil is in an engine and that oil is not available, the other type may be used in an emergency. If two types of oil are mixed, the engine oil shall be changed and the system flushed within 6 hours of engine operation. When oil is mixed, an entry shall be made in the Remarks Section of DA Form 2408-13.

e. Remove the filler cap. Fill the tank with oil until the indicator shows full. Do not overfill tank.

f. Install the filler cap. Close both access panels.

2-271. Auxiliary Power Unit (Apu) Oil System.

Service the apu as follows:

CAUTION

Do not use the apu drip pan as a handhold. Damage to equipment will result.

a. (See fig. 2-48.) Remove the filler cap from the left side of the apu.

CAUTION

Do not overfill. Damage to the apu can result from overfilling.

b. Add oil to the apu oil tank until the level reaches the FULL mark on the sight gage. Under normal conditions, the apu shall be serviced with one type of oil only. If one type of oil is in an apu and that oil is not available, the other type may be used in an emergency. If the two types of oil are mixed, the oil shall be changed and the system flushed within 6 hours of apu operation. When oil is mixed, an entry shall be made in the Remarks Section of DA Form 2408-13.

c. Reinstall and check security of the filler cap.

2-272. Transmission Oil System.

Service the forward transmission, engine/combining transmission, and aft transmission as follows:

a. (See fig. 2-48.) Access to oil filler and location of sight gage of each transmission are as follows:

(1) The oil filler and sight gage for forward transmission are accessible within the hinged fairing on the right side of the forward pylon. The filler neck is in the top forward area of the transmission. The sight gage is located in the bottom area below the filler neck; it can be viewed from above and can also be seen thru a viewing port in the canted bulkhead at sta 95 above the pilots seat.

(2) The oil filler and sight gage for aft transmission is on forward right side of the transmission sump. It is accessible from the cargo ramp area.

(3) The common oil filler and sight gage for the combining transmission and both engine transmissions are on the combining transmission oil tank. It is accessible within the fairing of aft pylon leading edge. Oil levels for combining and both engine transmissions are determined by the quantity displayed in the sight gage on the front of the combining transmission oil tank. Sight windows on the left and right sides of the tank are used only to ensure that oil is present in these two sections of the tank, and are not used to check oil level.

b. Refer to DA Form 2408-13 and table 2-3 for the type of oil to use. Under normal conditions, the transmissions shall be serviced with one type of oil only. If one type of oil is in a transmission and that oil is not available, the other type may be used in an emergency. If two types of oil are mixed, the transmission oil shall be changed and the system flushed within 6 hours of transmission operation. When oil is mixed, an entry shall be made in the Remarks Section of DA Form 2408-13.

c. Fill the forward transmission, engine/combining and aft transmissions to the FULL mark next to each sight gage.

NOTE

To prevent overfilling the engine/combining transmissions, check oil level within 30 minutes of shutdown. If the transmissions have been shut down for more than 30 minutes, operate the rotors for a minimum of 5 minutes to verify oil level before servicing. To ensure that the forward and aft transmission oil levels are properly indicated, wait a minimum of 30-minutes after engine shutdown before checking the levels.

2-273. Hydraulic Systems Servicing.

2-274. *Hydraulic Systems Fluid Servicing.* (See fig. 2-48.) The utility systems and both flight control hydraulic systems are serviced by a common fill module on the right side of the helicopter above the ramp. The fluid level indicators are on the maintenance panel above the fill module. One indicator is for both flight control hydraulic systems. The other indicator is for the utility system. Direct level checks can also be made from the reservoir piston rods. Service any system as follows:

a. Check the sight gage on the fill module reservoir for fluid level. If fluid cannot be seen on the sight gage, fill the reservoir.

b. Check the fluid level in the flight control reservoirs by selecting each system at the FLT CONTR switch on the maintenance panel. Then press the LEVEL CHECK switch. Check the fluid level in the utility reservoir by pressing the LEVEL CHECK switch.

c. Turn the system select valve to the position for the system to be serviced.

d. Using the handpump on the fill module, pump fluid into the system until the fluid in the reservoir is at the FULL mark. Keep the sight gage on the fill module full of fluid by adding fluid to the reservoir as required.

e. Turn the system select valve to OFF.

2-275. Hydraulic Systems Accumulator Servicing.

2-276. *Flight Controls Hydraulic Systems Accumulator Servicing.* (See fig. 2-48.) The No. 1 flight control system accumulator is within the forward transmission fairing, on the right side. The No. 2 system accumulator is within the aft pylon, on the right side. Charge either accumulator as follows:

a. Relieve pressure in the accumulator by cycling the cockpit controls several times.

b. Gain access to the accumulator. Access to the No. 1 accumulator is by lowering the forward transmission fairing right work platform. Access to the No. 2 accumulator is thru the aft pylon right access panel.

WARNING

> The high pressure air valve does not contain a valve core. Consequently, if valve leaks internally, air will be trapped between cap and metal-to-metal seal of valve. Allow this trapped air to escape by loosening the cap about one to two turns before removing cap.

c. Remove the cap from the high pressure air valve. Attach an air chuck to the valve stem.

d. While holding the valve body with a wrench, turn the upper hex nut counterclockwise one to two turns so that the valve is opened.

e. Charge the accumulator with dry air or nitrogen to the pressure indicated by the chart in Chapter 7.

f. Tighten the upper hex nut.

g. Remove the air filling chuck. Install the valve cap.

h. Close the work platform or install the access panel.

2-277. *Utility System Accumulators Servicing.* (See fig. 2-48.) There are five accumulators in the utility hydraulic system. They provide pressure to start the apu, operate the power brakes and swivel locks, and maintain line pressure throughout the system.

a. The apu start accumulator is the largest in the helicopter. It is mounted overhead in the cabin at the right of the aft transmission sump. Service the accumulator as follows:

Figure 2-49. (Deleted)

(1) Press the depressurization valve on the apu start module. Hold it in until system pressure is depleted.

WARNING

The high pressure air valve does not contain a valve core. Consequently, if a valve leaks internally, air will be trapped between cap and metal-to-metal seal of valve. Allow this trapped air to escape by loosening the cap about one to two turns before removing the cap.

(2) Remove the cap from the air valve. Attach an air chuck to the valve stem.

(3) While holding the valve body with a wrench, turn the hex nut ccw to open the valve.

(4) Charge the accumulator with air or nitrogen to the pressure indicated by the chart in Chapter 7.

(5) Tighten the hex nut to 50 to 70 pound-inches.

(6) Remove the air chuck. Install the valve cap.

b. The signal accumulator is part of the apu start module. It is aft and to the right of the apu start accumulator. Charge the signal accumulator to the pressure indicated by the chart in Chapter 7 in the manner of the apu start accumulator. (Refer to step a.)

c. The Power Steering and Swivel Lock Accumulator is on the right side of the cabin, in the cargo ramp area. Charge the accumulator as follows:

(1) Depressurize the accumulator by turning the BATT switch on the cockpit overhead switch panel to ON and cycling the swivel lock switch on the center console from LOCK to UNLOCK several times.

(2) Charge the accumulator to the pressure indicated on the chart in Chapter 7 in the manner of the apu start accumulator. (Refer to a(2) thru a(6).)

d. The brake accumulator is within the aft left side of the forward transmission fairing. Charge the accumulator as follows:

(1) Depressurize the accumulator by pressing the brakes several times.

(2) Charge the accumulator to 600 to 850 psi in the manner of the apu start accumulator. (Refer to step a.(2) thru a.(6).)

e. The utility reservoir pressurization (bootstrap) accumulator is forward of the No. 2 flight control accumulator in the aft pylon, accessible thru the pylon right access panel. Charge the accumulator as follows:

(1) Depressurize the accumulator by turning the handle on the UTILITY RESERVOIR DEPRESSURIZE valve to OPEN. The valve is on the right side of the cabin, in the cargo ramp area. Press the depressurization valve on the apu start module. Hold it in until system pressure is depleted. When the accumulator has been depressurized, return the handle of the UTILITY RESERVOIR DEPRESSURIZE valve handle to NORMAL.

(2) Charge the accumulator to the pressure indicated on the chart in Chapter 7 in the manner of the apu start accumulator. (Refer to step a.(2) thru a.(6).)

Figure 2-50. (Deleted)

Figure 2-51. (Deleted)

2-278. Tire Servicing.

If a tire required an excessive amount of air compared to the other tires on the helicopter, have the tire checked for leaks.

WARNING

> Remote Inflation Safety Chuck Gage AS1675 (30003) or equivalent shall be used when inflating tires.

a. Remove the cap from the air valve.

b. Attach the air chuck to the valve.

c. Inflate the tire to 88 psi.

d. Remove the air chuck. Install the valve cap.

2-279. Ground Handling (Towing).

(See fig. 2-52.) The following paragraphs describe two towing methods: normal towing and emergency towing. Normal towing is done with a standard Army towbar. This is the preferred method. However, the towbar must be modified with towbar kit, 114E5002-21, to adapt to the CH-47 aft landing gear. Emergency towing is accomplished with a cable or rope attached to the forward or aft landing gear. A steering bar, attached to the right aft gear, is used to steer the helicopter while it is being towed with the forward landing gear.

2-280. Normal Towing.

Proceed as follows: (See fig. 2-52.)

a. Check that utility system accumulator is pressurized to 2850 to 3100 psi. If pressure is below 2850 psi, pressurize the system to 2850 to 3100 psi with the utility handpump.

b. Check EMERG UTIL HYD valve OPEN.

c. Check to ensure the swivel locks are disengaged.

d. Attach the tow bar to right aft landing gear axle. Secure the spreader bar to the tow bar.

e. Connect the tow bar to the towing vehicle.

f. Station one crew member in the cockpit to operate brakes.

CAUTION

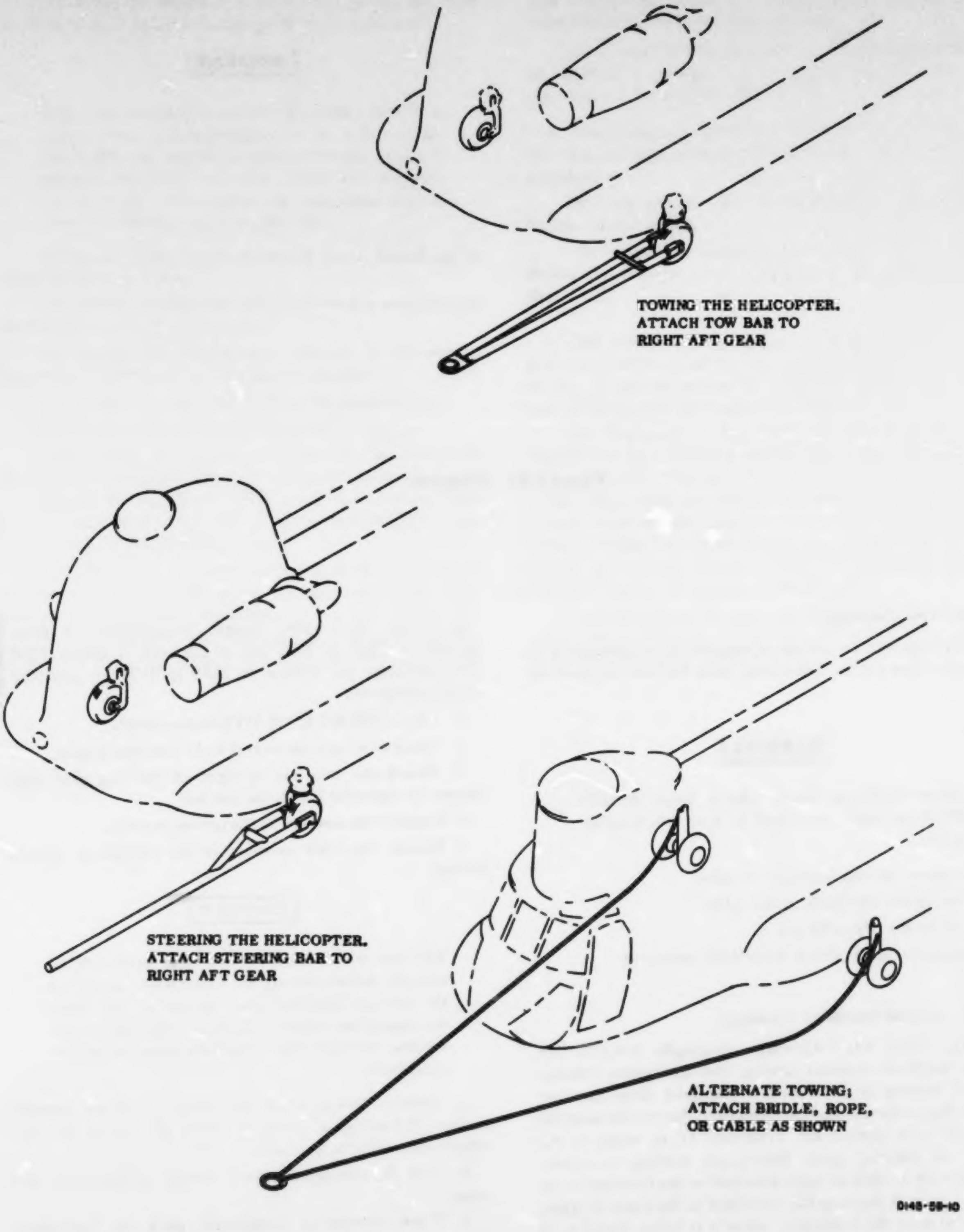
> The free wheel shall be swiveled about 120° to one side before towing aft. Otherwise, damage to the tire and landing gear can result. To avoid damaging the rotary-wing blades, station a crewmember on each side of the helicopter to observe clearances.

g. Remove chocks from the wheels. Release parking brakes. If helicopter is to be towed aft, swivel the free wheel about 120° to one side.

h. Tow the helicopter slowly. Avoid sudden starts and stops.

i. When towing is completed, park the helicopter. (Refer to para 2-282.) Both aft gear shall be returned to trail position. Disconnect towing equipment from helicopter.

j. Check EMERG UTIL HYD valve — CLOSED.



TOWING THE HELICOPTER. ATTACH TOW BAR TO RIGHT AFT GEAR

STEERING THE HELICOPTER. ATTACH STEERING BAR TO RIGHT AFT GEAR

ALTERNATE TOWING; ATTACH BRIDLE, ROPE, OR CABLE AS SHOWN

Figure 2-52. Towing the Helicopter

2-281. Alternate Towing.

This method of towing is used only when normal method of towing cannot be used.

a. Check that the utility system accumulator is pressurized to 3,000 psi. If pressure is below 3,000 psi, pressurize the system to 3,000 psi with the utility handpump.

CAUTION

Make sure the towing rope or cable is long enough to allow turning and stopping clearance between towing vehicle and helicopter. Two 29-foot lines will provide clearance of about 10 feet.

b. Attach a towing bridle, if available, or a rope or cable of sufficient length and strength, to tiedown rings on forward or aft landing gear, whichever is applicable.

CAUTION

Be careful when towing with rope or cable. Helicopter brakes are the only means of stopping the helicopter. Station a crewmember on each side of the helicopter to stand by with wheel chocks in event of brake malfunction and to watch for blade clearance.

c. If helicopter is being towed forward, attach a steering bar to an aft landing gear axle. If the apu can be operated, start the apu, and use power steering and brakes.

d. Connect the towing bridle, towing rope, or cable to the towing vehicle. Position the towing vehicle so the slack is just removed from the towing bridle, rope or cable. If the apu is not operating, open the EMERG UTILITY PRESS valve, station a crewmember by the utility accumulator gage to monitor pressure and to pressurize the system when utility pressure drops below 2,800 psi.

e. Station one crewmember in the cockpit to operate the brakes.

CAUTION

The free wheel shall be swiveled about 120° to one side before towing aft. Otherwise, damage to the tire and landing gear can result. To avoid damaging the rotary-wing blades, station a crewmember on each side of the helicopter to observe clearances.

f. Remove chocks from the wheels. Release parking brakes. If helicopter is to be towed aft, swivel the free wheel about 120° to one side.

g. Tow helicopter slowly. Avoid sudden starts and stops. Avoid sharp turns which could cause the cable to damage antennas.

h. When towing is completed, park the helicopter. The aft gear shall be in the trail position. (Refer to para 2-282.) Disconnect towing equipment from helicopter.

2-282. Parking.

Park the helicopter as directed in the following steps:

a. Apply wheel brakes. Then, set the parking brakes.

b. Place chocks against front and back of forward and aft tires.

CAUTION

Failure to position blades properly can allow a blade to hit the fuselage. This may damage the fuselage and blade.

c. Position rotary-wing blades 30° off centerline of helicopter.

d. Unplug the battery after the last flight of the day.

e. Lock all doors and hatches.

f. Moor the helicopter, if necessary. (Refer to para 2-283.)

2-283. Mooring.

(See fig. 2-53.) The helicopter can be secured with tiedown lines 114E5060-1 or equivalent to permanent fittings at a hardstands or to fittings of mooring kit AN8015-2 in unpaved areas. The methods of mooring vary with intensity of winds. Table 2-6 provides necessary precautions to be taken pertaining to these conditions.

CAUTION

To prevent damage to the helicopter, be sure to tie down the rotor blades on parked helicopters. The wide chord rotor blades on the helicopter will rotate in a light wind.

Table 2-6. Mooring Data

WIND VELOCITY	TIEDOWN REQUIREMENT
0 to 39 mph	Two forward blades tied down as shown in fig. 2-53.
39 to 65 mph	Fuselage and blades tied down
Over 65 mph	Evacuate helicopter from the area or store helicopter in hangar

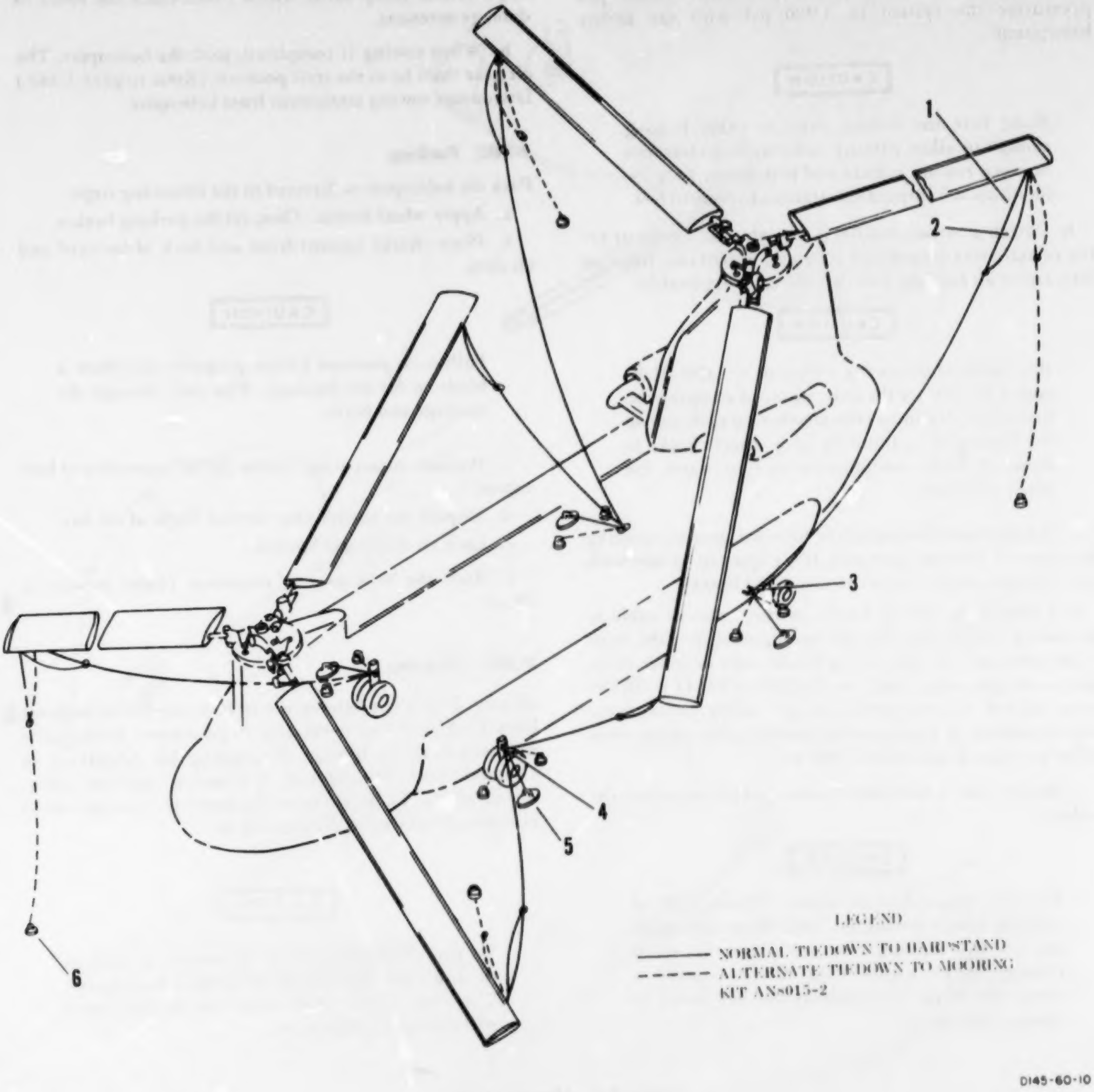

1
2
3
4
5
6
LEGEND
NORMAL TIEDOWN TO HARDSTAND
ALTERNATE TIEDOWN TO MOORING KIT AN8015-2
D145-60-10

Figure 2-53. Mooring the Helicopter

a. Park the helicopter. (Refer to para 2-282.) If mooring the helicopter to hardstand, position the helicopter so tiedown fittings (3 and 4) are close to a mooring fitting (5).

b. Working from the walkway on top of the fuselage, insert blade interlock of blade anchor assembly (1) into anchor fitting at tip of the nearest blade.

c. Use the tiedown line of the installed blade anchor assembly to pull the next blade into position so that its blade anchor assembly can be installed.

d. Repeat steps b. and c. until all blade anchors are installed.

e. Position blades so one blade of one rotor extends perpendicularly from the left side of the helicopter and one blade of the other rotor extends perpendicularly from the right side of the helicopter.

f. Secure each of the blades to the tiedown fittings of the helicopter with the lines from the blade anchors.

g. Secure the helicopter with lines from the mooring fittings on the landing gear to the nearest mooring fittings on the hardstand. If the helicopter is to be tied down in an unpaved area, use mooring kit AN8015-2. If the kit is used, secure the two foremost and two aftermost blades to the tiedown fittings of the kit instead of to the landing gear fittings.

h. Install protective covers.

2-284. Protective Covers.

(See fig. 2-54.) The following protective covers should be stowed in the helicopter. They are used as necessary whenever helicopter is parked or moored.

a. Engine (lh) inlet cover 219G1001-1.

b. Engine (rh) inlet cover 219G1001-1.

c. Engine outlet cover 114G1323-1 (2 ea).

d. Hydraulic cooler exhaust cover 145G0004-1.

e. Pitot tube covers 114E5040-33 (2 ea).

f. Aft transmission cooler and apu exhaust cover 145G0005-1.

g. Transmission and hydraulic cooler intake 145G0001-1.

h. Transmission and hydraulic cooler exhaust 145G0002-5 (lh) and -6 (rh).

i. Transmission and hydraulic cooler inlet (aft pylon) 1450003-1.

j. Cockpit enclosure protective cover 145G0006-1.

k. Rotor hub protective cover 114G1023 (2 ea).

l. Heater exhaust protective cover 114G1025-1.

m. Heater inlet cover 114G1024-1.

2-285. Helicopter Security.

(See fig. 2-55.) The helicopter is equipped with door lock security devices. These devices prevent interior access to the helicopter by unauthorized persons. Install the devices as follows:

a. Make sure the ramp is full up. Install the cable hook thru the ramp controls access door latch. Secure the fastener to the bracket. Make sure the warning streamer is visible.

b. Close the lower rescue hatch door. If the door cannot be closed, secure the utility hatch to a tiedown ring with a cargo strap.

c. Secure the release straps of the two cabin escape hatches and the cargo door escape hatch with restraining clamps. Make sure the clamps are located as close to the release grommet as possible. Make sure the warning streamers are readily visible.

d. Install lock pins thru the pilot's and copilot's window latches. Then, insert the quick-release pin thru the bracket on the floor and into the door latch plate. Make sure the warning streamers are readily visible.

e. Close the cabin doors. Install the bracket with the padlock.

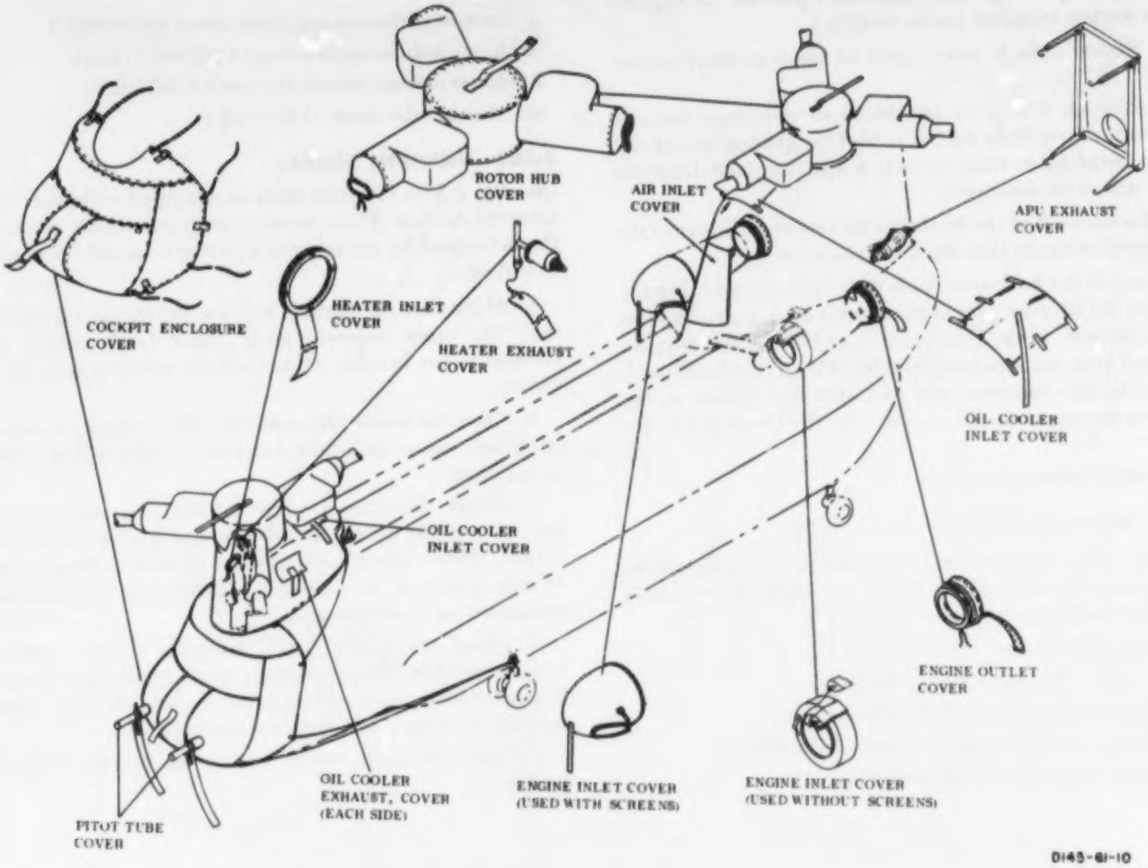

ROTOR HUB COVER
AIR INLET COVER
APU EXHAUST COVER
COCKPIT ENCLOSURE COVER
HEATER INLET COVER
HEATER EXHAUST COVER
OIL COOLER INLET COVER
OIL COOLER INLET COVER
ENGINE OUTLET COVER
PITOT TUBE COVER
OIL COOLER EXHAUST, COVER (EACH SIDE)
ENGINE INLET COVER (USED WITH SCREENS)
ENGINE INLET COVER (USED WITHOUT SCREENS)
D145-61-10

Figure 2-54. Protective Covers

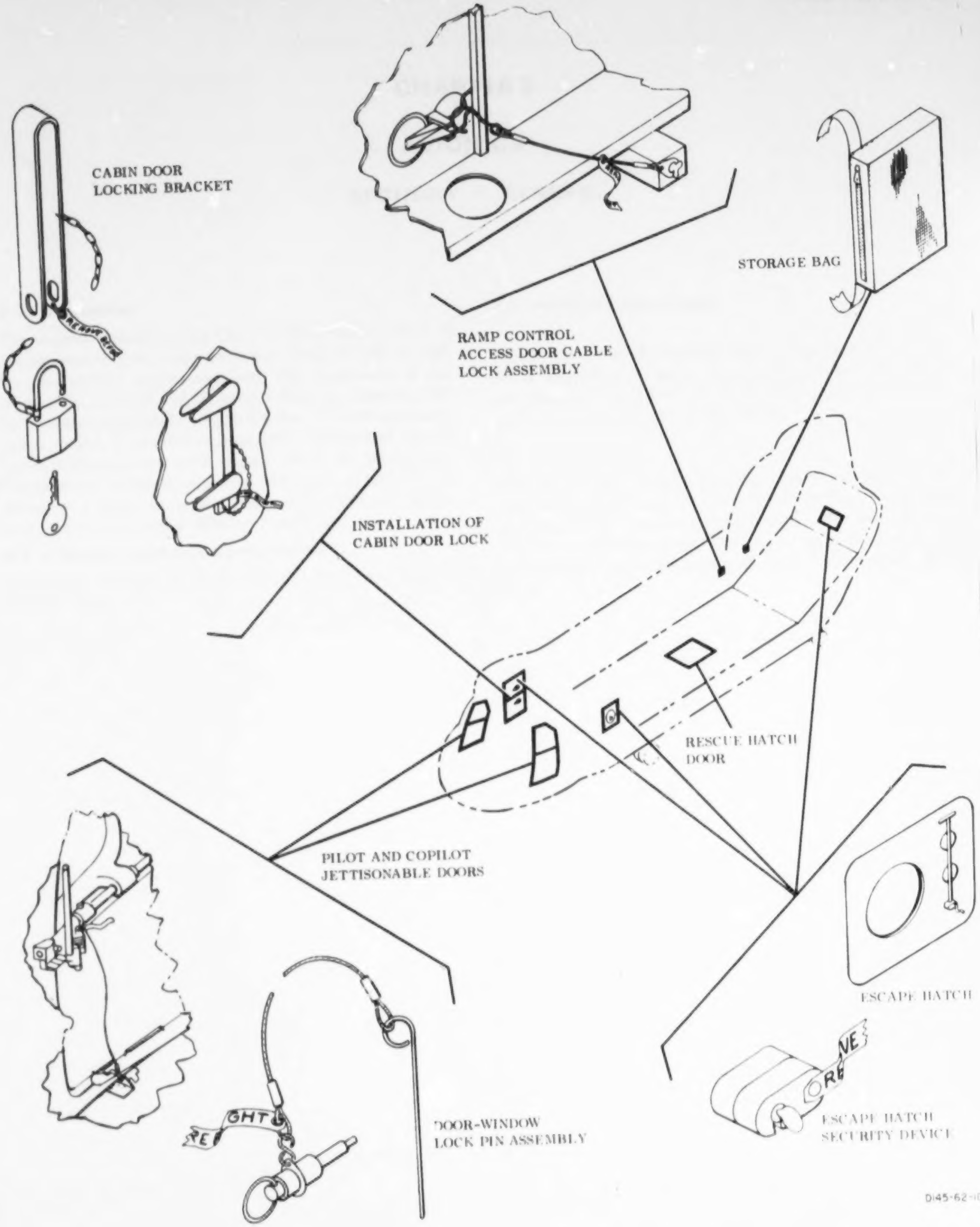

CABIN DOOR LOCKING BRACKET
RAMP CONTROL ACCESS DOOR CABLE LOCK ASSEMBLY
STORAGE BAG
INSTALLATION OF CABIN DOOR LOCK
RESCUE HATCH DOOR
PILOT AND COPILOT JETTISONABLE DOORS
ESCAPE HATCH
ESCAPE HATCH SECURITY DEVICE
DOOR-WINDOW LOCK PIN ASSEMBLY
RE
GHT
VE
RE
D145-62-10

Figure 2-55. Installation of Helicopter Security Devices

CHAPTER 3

AVIONICS

SECTION I GENERAL

3-1. Description.

The avionic systems in the CH-47D helicopters consist of the communications equipment providing hf, vhf-am, vhf-fm, and uhf-am communications. The navigation equipment includes lf-adf, vor ils, marker beacon, Doppler. Vhf-fm homing is provided through the No. 1 vhf-fm communication radio. Transponder equipment consists of an IFF receiver-transmitter with inputs from the barometric altimeter for altitude encoding. Absolute height is provided by a radar altimeter. For mission avionics equipment, refer to Chapter 4, Mission Equipment.

3-2. Avionics Equipment Configuration.

Equipment configuration in the CH-47D helicopter is listed in table 3-1.

3-3. Avionics Power Supply.

Power to operate the avionic systems is provided from the No. 1 and No. 2 dc buses, the essential dc bus, and No. 1 and No. 2 115-volt and 26-volt ac buses. (See figures 2-39 and 2-35, electrical system diagrams.)

The No. 1 vhf am/fm, interphone and uhf sets can be operated by selecting the BATTery switch on. To operate the remaining avionics equipment, the apu generator, or the main helicopter generators, must be operating, or ac ground power must be connected. All circuit breakers must be in.

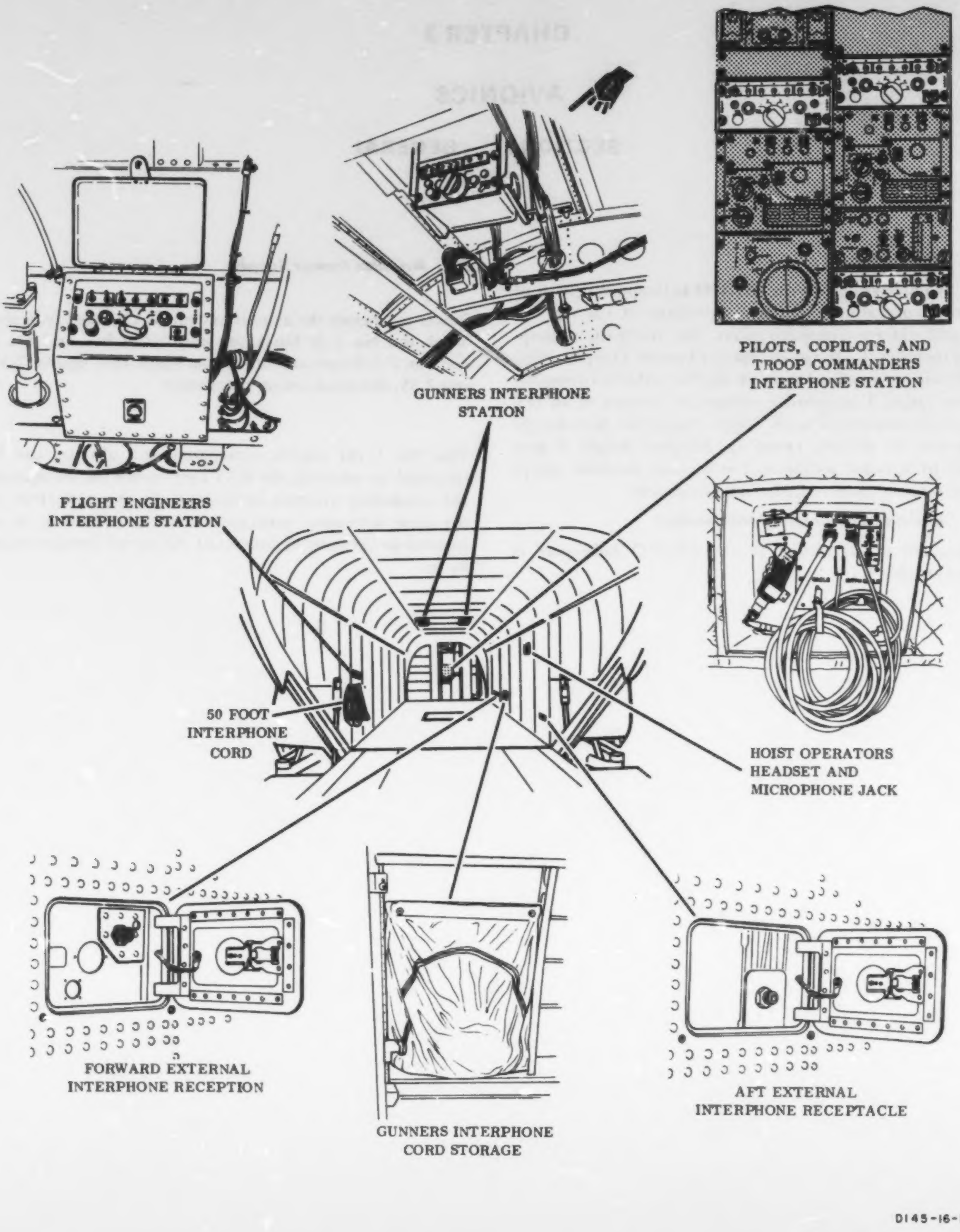

PILOTS, COPILOTS, AND TROOP COMMANDERS INTERPHONE STATION
FLIGHT ENGINEERS INTERPHONE STATION
GUNNERS INTERPHONE STATION
50 FOOT INTERPHONE CORD
HOIST OPERATORS HEADSET AND MICROPHONE JACK
FORWARD EXTERNAL INTERPHONE RECEPTION
GUNNERS INTERPHONE CORD STORAGE
AFT EXTERNAL INTERPHONE RECEPTACLE
D145-16-10

Figure 3-1. Interphone Stations

Table 3-1. Communications/Navigation Equipment

FACILITY	DESIGNATION	USE	LOCATION
INTERPHONE	C-6533/ARC	INTERCOMMUNICATION BETWEEN CREWMEMBERS AND RADIO CONTROL	THREE INTERPHONE CONTROLS ON CONSOLE, THREE INTERPHONE CONTROLS IN CABIN
UHF RADIO	AN/ARC-164	TWO-WAY UHF-AM COMMUNICATIONS	CONTROL ON CONSOLE (INCLUDES R/T)
VHF AM/FM RADIOS (2)	AN/ARC-186	TWO-WAY VHF AM/FM COMMUNICATIONS	CONTROL ON CONSOLE (INCLUDES R/T)
VOICE SECURITY EQUIPMENT	TSEC/KY-28/58	TWO-WAY CLEAR OR SECURE VOICE COMMUNICATION FOR NO. 1 VHF/FM RADIO	CONTROL ON CONSOLE
HIGH FREQUENCY RADIO SET	AN/ARC-102	LONG RANGE TWO-WAY COMMUNICATIONS	CONTROL ON CONSOLE
VHF NAVIGATION AND INSTRUMENT LANDING SYSTEM	AN/ARN-123	PROVIDES VOR BEARING AND COURSE INFORMATION, ILS LOCALIZER, GLIDESLOPE, AND MARKER BEACON INDICATIONS	CONTROL ON CANTED CONSOLE
DIRECTION FINDER SET	AN/ARN-89	AUTOMATIC OR MANUAL DIRECTION FINDING AND HOMING	CONTROL ON CANTED CONSOLE
GYROMAGNETIC COMPASS SET	AN/ASN-43	PROVIDES HEADING INFORMATION IN FREE GYRO OR MAGNETIC MODES	CONTROL ON OVERHEAD SWITCH PANEL
DOPPLER NAVIGATION SET	AN/ASN-128	PROVIDES WORLDWIDE NAVIGATION CAPABILITY WITHOUT USE OF GROUND FACILITIES	CONTROLS ON CANTED CONSOLE
RADAR ALTIMETER	AN/APN-209	INDICATES ABSOLUTE ALTITUDE	ON BOTH PILOTS INSTRUMENT PANELS
TRANSPONDER SYSTEM	AN/APX-100	RADAR IDENTIFICATION AND TRACKING	CONTROL ON CANTED CONSOLES
RADAR WARNING SET	AN/APR-39	PROVIDES VISUAL AND AURAL WARNING OF RADAR AND MISSILE THREATS	CONTROL ON CONSOLE
MISSILE DETECTOR SET	AN/ALQ-156	DETECTS MISSILE APPROACH AND INITIATES COUNTERMEASURES	CONTROL ON CONSOLE
FLARE DISPENSER	M-130	LAUNCHES FLARES AS A COUNTERMEASURE TO INFRA-RED SEEKING MISSILES	CONTROL ON CONSOLE
Omega Navigation System	AN/ARN-148	Provides navigation capability using ground facilities	Control on console

SECTION II COMMUNICATIONS

3-4. Interphone System (C-6533/ARC).

The interphone system is a multi-station intercommunication and radio control system for control of voice radio communication. It also monitors the output of navigation radio receivers and warning tones from IFF and radar warning sets. The basic components of the interphone system are six control panels. There is one panel each for the pilot, copilot, troop commander, the two gunners stations, and flight engineer. In addition, there is an interphone station for the hoist operator and two external interphone receptacles. Power for the system is supplied by the 28-volt dc essential bus thru the INTPH circuit breakers on the No. 1 and No. 2 power distribution panels.

3-5. Controls and Function, Interphone Control (C-6533/ARC).

See fig. 3-2.

CONTROL/ INDICATOR	FUNCTION
Function Selector Switch Position	Five position rotary switch used to select interphone operating mode.
ICS	Connects headset-microphone to interphone system.
1	Connects headset-microphone to No. 1 vhf am/fm radio set.
2	Connects headset-microphone to uhf radio set.
3	Connects headset-microphone to No. 2 vhf am/fm radio set.
4	Connects headset-microphone to hf radio set.
5	Not used.

NOTE

Pilot/Copilot can transmit on all four transmitters. Troop Commander can transmit on the hf and No. 1 vhf am/fm transmitters only. Gunners and Flight Engineer cannot access any transmitters.

Receiver Switches 1-5, AUX and NAV Position	Seven two position toggle switches used to select headset audio input as follows: 1 - No. 1 vhf am/fm radio 2 - Uhf radio 3 - No. 2 vhf am/fm radio 4 - Hf radio 5 - Not used AUX - vor/localizer NAV - direction finder OFF disables associated audio input to headset. ON radio enables associated input to headset.
HOT MIKE Switch Position	Two position toggle switch enables hands-free operation (PTT/foot switch operation not required) of headset microphone for interphone only.
OFF	Hands-free operation disabled. PTT/foot switch operation required for operation.
HOT MIKE	Hands-free operation enabled.

NOTE

Switch settings are not necessary to receive marker beacon, radar warning, and IFF audio tones.

Press to talk (PTT) Switches Position	Two or three position switches used to enable the microphone side of the interphone system when operator is speaking. These switches are described in detail below.
Pilot/Copilot Trigger PTT Switch (on pilot and copilot cyclic stick) Position	Three position PTT switch. Off disables microphone (not pressed) enables headset.
Interphone (First detent)	Enables microphone transmission to all interphone stations, regardless of function switch settings.
Radio transmit (Second detent)	Enables microphone transmission over radio set selected by control panel function switch.
Pilot's/Copilot's Foot Switches (on cockpit floor next to heel slide) Position	Two position PTT switch.
Off	Released position; disables microphone, enables headset.
Talk	Depressed position; enables headset microphone.
Hoist Control PTT Switch (on hoist control grip) Position	Two position PTT Switch.
Off	Released position; disables microphone, enables headset.
Talk	Depressed position; enables headset microphone.

CONTROL/ INDICATOR	FUNCTION
Hoist Operators Function Switch Position	Three position switch selects hoist operator's Interphone operating mode.
OFF	Requires operation of PTT switch for Interphone communications.
HOT MIKE	Operation of PTT Switch not required for Interphone communications.
MOM ON	Same as HOT MIKE.
Gunner's Foot Switch Position	Two position pressure sensitive switch mounted in moveable floor mat.
Off	Released position; disables microphone.
On	Depressed position; enables microphone.

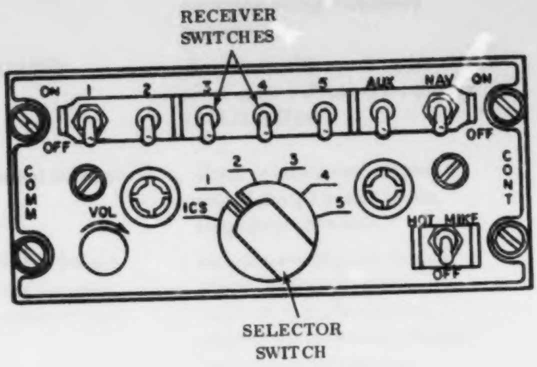

RECEIVER SWITCHES
ON
1
2
3
4
5
AUX
NAV
ON
OFF
OFF
COMM
CONT
VOL
ICS
1
2
3
4
5
HOT MIKE
OFF
SELECTOR SWITCH

Figure 3-2. Interphone Control (C-6533/ARC)

3-6. Antenna System.

Aircraft antennas used with avionics communications and electronics equipment are shown in Figure 3-3. This figure shows the maximum antenna configuration. All antennas presented may not appear on all aircraft.

3-7. UHF Radio (AN/ARC-164).

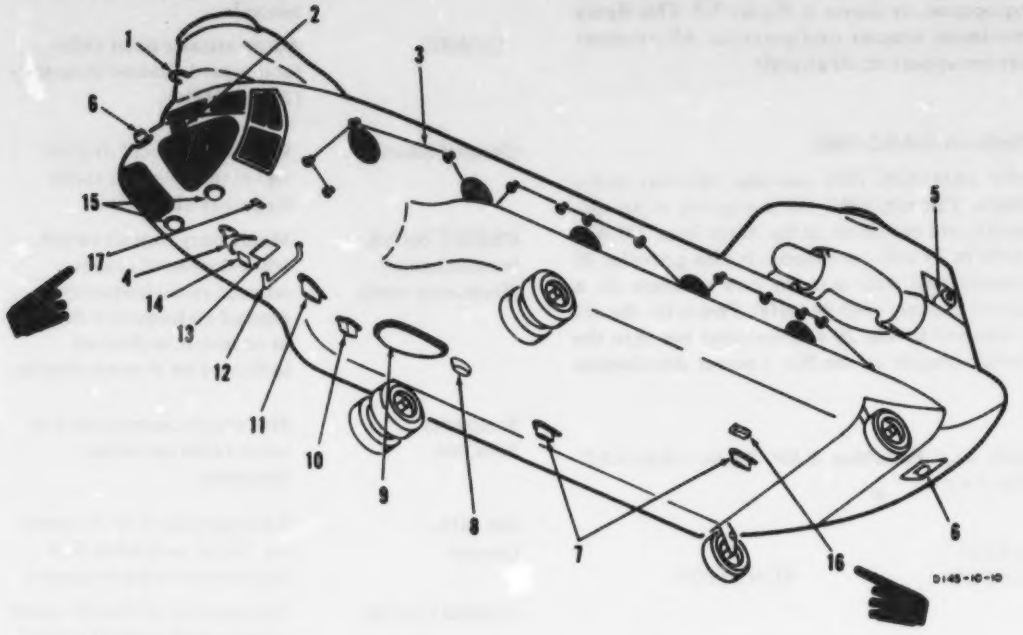
The uhf radio (AN/ARC-164) provides two-way radio communications. The AN/ARC-164 is capable of providing transmission and reception in the band from 225.000 to 399.975 mHz in 25 kHz increments. It also provides 20 preset frequencies and will monitor and transmit on a permanent guard channel (243.00 mHz). Power for the uhf radio set is supplied by the 28-volt essential bus thru the UHF/AM circuit breaker on the No. 1 power distribution panel.

3-8. Controls and Function UHF Radio (AN/ARC-164.) (See fig. 3-4.)

CONTROL/ INDICATOR	FUNCTION
Function Select Switch	Four position rotary switch used to select radio operating mode.
OFF	Power to set is disabled; radio set inoperative.
MAIN	Radio set can be used to transmit and receive; guard channel inoperative.
BOTH	Radio set can be used to transmit and receive; guard receiver operates.
ADF	Not used.
VOL	Rotary control used to adjust radio output volume.
SQUELCH Switch	Two position toggle switch; select radio squelch mode.
OFF	Squelch is disabled.
ON	Squelch is enabled.
Frequency Mode Selector	Three position rotary control use to select frequency tuning mode.
PRESET	Permits selection of channel frequencies to be preset in radio set (Maximum of 20 channels).
MANUAL	Permits manual frequency selection using frequency controls.
GUARD	Automatically tunes radio set to guard channel frequency (243.00 MHz)
Channel Selector	Used to select and display any of the 20 preset radio frequency channels.
PRESET Switch (underchannel /frequency card)	Momentary contact switch, when depressed causes selected radio frequency entered on frequency display to be stored in channel indicated on channel display.
Frequency Selectors	Five rotary controls used to select radio operating frequency.
100 MHz Control	Two position (2 or 3) rotary control used to select first digit of operating frequency.
10 MHz Control	Ten position (0 thru 9) rotary control used to select second digit of operating frequency.
1 MHz Control	Ten position (o thru 9) rotary control used to select third digit of operating frequency.
0.1 MHz Control	Ten position (0 thru 9) rotary control used to select fourth digit of operating frequency.
0.025 MHz Control	Four position rotary control used to select fifth and sixth digits of operating frequency. Operates in 0.025 MHz increments.
TONE	Momentary contact switch, when pressed, causes 1020 Hz tone to be transmitted on radio operating frequency.
Frequency Display	Six digit display, (200.00 thru 399.975) displays selected radio operating frequency.
CHAN	Displays selected preset channel.

3-9. Normal Operation — UHF Radio. The following steps provide operating procedures.

a. Starting.


1
2
3
6
15
17
4
14
13
12
11
10
9
8
7
16
5
6
D145-10-10

1. Glide slope
2. Radar warning
3. Hf
4. Vhf navigation
5. Radar warning
6. Iff
7. Ecm antennas
8. Marker beacon
9. Adf loop and sense antennas
10. Uhf
11. Vhf am/fm (typical top and bottom)
12. Fm homing
13. Doppler navigation
14. Radar warning blade antenna
15. Radar altimeter
16. Omega antenna
17. Omega temperature probe

Figure 3-3. Antenna Locations

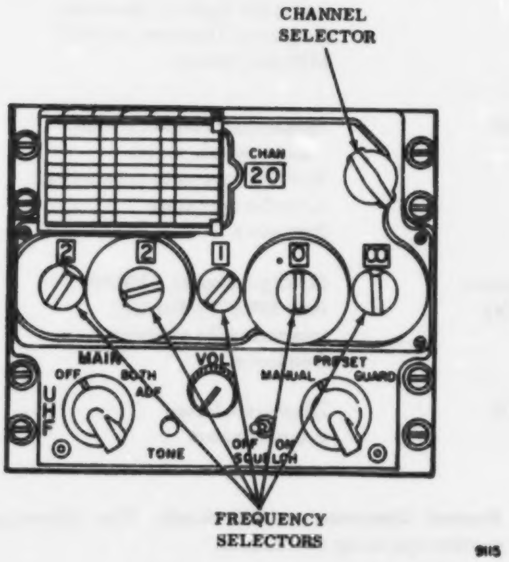

CHANNEL
SELECTOR
CHAN
20
2
2
1
.0
00
MAIN
OFF
BOTH
ADF
VOL
PRESET
MANUAL
GUARD
U
H
F
TONE
OFF ON
SQUELCH
FREQUENCY
SELECTORS
9115

Figure 3-4. UHF Radio (AN/ARC-164)

1. Interphone control panel — Set switches as follows:

   (a) Receiver 2 switch — ON.

   (b) Function select switch — 2.

2. Function switch — MAIN or BOTH.
3. Mode selector — As required.
4. SQUELCH switch — As required.
5. VOL control — As required.

b. Presetting Channels. Perform the following steps to preset a channel to a desired frequency.

1. Set the Frequency Mode Selector to PRESET.
2. Use the manual frequency selector switches to select the frequency to be placed in memory.
3. Turn the preset channel control switch to the desired channel number.
4. Raise the cover under the channel card. Press and release the PRESET switch. Close the cover.
5. Using a soft lead pencil, record the frequency selected for the channel number on the card provided.

c. Stopping. Function switch — OFF.

b. Antenna select system. Three antennas are installed as part of the AM/FM radio installation: A top and bottom communications antenna and a fm homing antenna. Both AM and FM can be transmitted and received over the same antenna but not at the same time. Antenna selection is controlled by the two position VHF ANT SEL switch on the center instrument panel. The normal switch position is down at the SYS 2 - SYS 1 position; No. 2 set is connected to the top antenna and No. 1 set is connected to the bottom antenna. If a water landing is to be made or the bottom antenna is damaged, setting the switch up to SYS 1 SYS 2 reverses the normal antenna connections and connects No. 1 set to the top antenna and No. 2 set to the bottom antenna. This ensures that secure voice is available from set No. 1 thru the top antenna. Power to operate the system is obtained from the essential dc bus thru the VHF ANT SEL circuit breaker on the No. 2 pdp.

NOTE

The antenna select system has no effect on the fm homing antenna. The homing antenna (towel bar) is on the bottom of the fuselage aft of the cockpit (fig. 3-3) and is connected to No. 1 set only.

3-11. *Controls and Function, Vhf Am/Fm Radio Set.*

(See fig. 3-5.)

CONTROL/ INDICATOR	FUNCTION
Mode Select Switch	Three position rotary switch used to select radio operating mode.
OFF	Power to set is disabled, radio is inoperative.
TR	Radio operates in the transmit-receive mode.
DF	Radio operates in the direction finder mode.
Frequency Select Switch	Four position rotary used to select radio frequency tuning mode.
EMER AM	Radio is tuned to AM Guard channel frequency.
EMER FM	Radio is tuned to FM Guard channel frequency.
MAN	Allows manual tuning of radio operating frequency.
PRE	Allows selection of any of 20 preset operating frequencies.
VOL	Rotary control adjusts radio output volume.
SQ DIS/TONE Switch	Three position toggle switch used to select radio squelch operation.
Normal (center position)	Preset squelch level is selected.
SQ DIS	Squelch operation is disabled.
TONE	Transmits 1000 Hz tone on selected frequency (primarily maintenance operation).
Preset Channel Selector	Twenty position rotary control used to select any of 20 preset channel frequencies.
CHAN	Display selected preset channel number.
Frequency Controls	Four rotary controls used to manually select radio operating frequency.
10 MHz Control	Thirteen position (03 thru 17) rotary control used to select first and second digits of operating frequency.
1 MHz Control	Ten position (0 thru 9) rotary control used to select third digit of operating frequency.
0.1 MHz Control	Ten position (0 thru 9) rotary control used to select fourth digit of operating frequency.
0.025 MHz Control	Four position rotary control used to select fifth and sixth digits of operating frequency in 0.025 MHz increments.
Frequency Display	Display selected radio operating frequency.
WB/NB/ MEM LOAD Switch (under channel card)	Three position toggle switch used to select radio operating band and during preset channel frequency loading.
NB	Places radio in NB (Narrow band) operation.
WB	Places radio in WB (wide band) operation.

NOTE

Switch will remain in WB position unless otherwise instructed by radio set controller.

MEM LOAD	Momentary contact position used with frequency controls and channel selector to load preset channels.

3-12. Normal Operation — Am/Fm Radio Set. The following steps provide operating procedures.

a. Starting.

1. Interphone control panel — Set switches as follows:

   (a) Receiver 1 or 3 switch — ON.

   (b) Selector switch — 1 or 3.

2. VHF ANT SEL switch — SYS 2 - SYS 1.

NOTE

No. 1 set is connected to interphone position No. 1. No. 2 set is connected to interphone position No. 3.

b. Transmit-receive mode.

1. Mode select switch — TR.

2. Frequency select switch — as required. If set to MAN, select the desired frequency with the frequency select controls. If set to PRE, rotate the CHAN switch until the desired channel appears in the window.

3. VOL control — as required.

4. SQ DIS switch — center position. If greater receiver sensitivity is required, set the switch to SQ DIS.

c. Homing.

1. Mode select switch — DF.

2. Operating frequency — set.

NOTE

Any strong signal within the frequency range of the radio set can be used for homing.

3. FM button on HSI MODE SELECT PANEL — press. Check that SEL lamp is lit.

4. Homing procedures. The course deviation bar on the horizontal situation indicator provides the primary navigation indication when the set is in homing mode. The bar only provides information on whether the helicopter is left, right, on a heading to the signal source, or over the signal source. The TO-FROM ambiguity arrows will not function and the selective course feature is not available. Ambiguity is solved using either of the following methods:

   (a) Directional method. When the helicopter is heading inbound to the signal source with the bar centered, the indications are directional in that a change in heading to the right will cause the bar to drift to the left. Conversely, a change in heading to the left will cause the bar to drift to the right. When the helicopter is heading outbound from the signal source with the vertical pointer centered, the indications are nondirectional in terms of steering. A change in heading to the right will cause the bar to drift to the right. A change in heading to the left will cause the bar to drift left.

   (b) Build and fade method. If the signal source is transmitting a 150-Hz tone-modulated signal and the helicopter is inbound to the signal source, the tone will increase in intensity. The tone will decrease in intensity on an outbound heading.

5. Additional homing characteristics. The following additional characteristics may be observed when homing. The glideslope deviation pointer will rise from the horizontal mark when the aircraft is inbound (increasing signal strength) to a transmitter. The pointer will fall to the horizontal mark when outbound. The glideslope failure and navigation failure warning flags will be in view if there is inadequate homing signal strength. A dip in the horizontal pointer may or may not occur when passing over the station, depending on the signal source, helicopter speed, and altitude.

d. Stopping. Mode select switch — OFF.

e. Presetting channels. Perform the following steps to preset a channel to a desired frequency.

1. Mode select switch — TR.

2. Frequency select switch — MAN.

3. Rotate the four frequency select switches until the desired frequency is displayed.

4. Rotate the preset channel selector until the desired channel appears in the preset CHAN indicator.

5. Remove the snap-on cover.

6. Momentarily set the band with WB, NB, MEM LOAD switch to MEM LOAD. The preset frequency is now in memory.

7. Using a soft lead pencil, record the loaded frequency opposite the channel number on the snap-on cover.

8. Using the above procedure, preset any other channels and install the snap-on cover.

3-13. Deleted.

3-14 and 3-15 Deleted

Page 3-9 and Fig. 3-6 Deleted

3-14. *Controls and Function, Voice Security System Control Panel (C-8157/ARC).* (See fig. 3-6.)

CONTROL/ INDICATOR	FUNCTION
Power Switch	Two position switch controls dc power to TSEC/KY-28.
Down	Dc power not applied, TSEC/KY-28 inoperative.
Up	Dc power applied, TSEC/KY-28 operates.
POWER ON Indicator (amber)	Lights when TSEC/KY-28 power switch is in the Up position.
Plain/Cipher Switch	Two position lever-lock switch controls TSEC/KY-28 security mode.
PLAIN	Unsecured normal voice transmission/reception enabled through the TSEC/KY-28.
CIPHER	Secure voice transmission/reception enabled through the TSEC/KY-28.
Mode Indicators	Light to indicate TSEC/KY-28 operating mode.
CIPHER (green)	Lights when TSEC/KY-28 is operating in the secured mode.
PLAIN (red)	Lights when TSEC/KY-28 is operating in the unsecured (clear) mode.
RE-X/REG	Two position lever-lock switch used to select normal TSEC/KY-28 operation or extended range operation through a retransmission facility.
RE-X	TSEC/KY-28 operates in extended range mode (for secure voice operation only).
REG	TSEC/KY-28 operates in normal mode (secure or clear voice operation).
ZEROIZE Switch	Two position switch (with spring-loaded cover) used to disable the TSEC/KY-28 in an emergency and clears any entered codes.
Down	Allows normal TSEC/KY-28 operation, switch is held in this position by spring-loaded cover.
Up	Causes emergency disabling of TSEC/KY-28 and clears any entered codes.

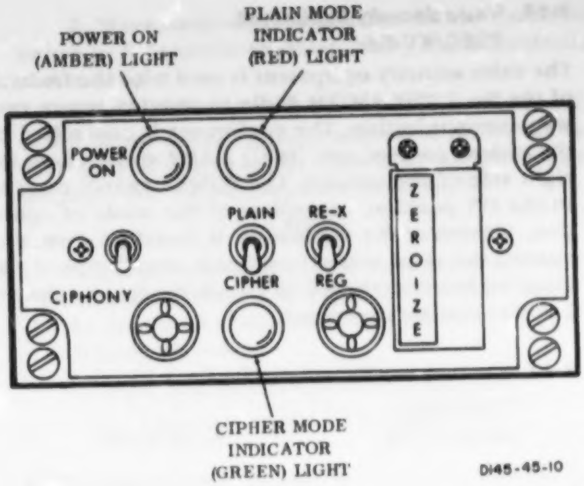


Figure 3-6. Control Panel TSEC/KY-28 (C-8157)

3-15. *Normal Operation*. The following steps provide voice security system operating procedures.

a. Starting.

1. NO. 1 AM/FM RADIO — On.

2. Power switch — Up. The amber indicator light comes on and a beeping tone will be heard in the headset. Before the set can be used, the tone must be cleared by momentarily keying the No. 1 VHF AM/FM Radio with the PTT switch.

3. Plain-Cipher switch — As required. At PLAIN, a red indicator light comes on. At CIPHER, a green indicator light comes on.

4. RE-X-REG switch — REG.

5. Trigger switch — press and hold at second detent. If CIPHER is selected, wait until a beep is heard before transmitting. The set is now ready for secure transmissions.

b. Stopping. Power switch — DOWN.

c. Zeroizing procedures. This clears any encoding in the KY-28.

1. ZEROIZE switch cover — lift and hold.
2. ZEROIZE switch — up.
3. Plain-Cipher switch — PLAIN.

3-16. *Voice Security Equipment TSEC/KY-58.*

The voice security equipment is used with the fm band of the No. 1 VHF AM/FM Radio to provide secure two-way communication. The equipment is controlled by the remote control unit (RCU) Z-AHP mounted on the right side of the console. The POWER switch must be in the ON position, regardless of the mode of operation, whenever the equipment is installed. Power to operate the voice security system is supplied by the dc essential bus thru the KY-28 circuit breaker on the No. 2 power distribution panel.

3-17. *Controls and Functions.* (See fig. 3-7.)

CONTROL/ INDICATOR	FUNCTION
ZEROIZE Switch (under spring-loaded cover)	Momentary contact toggle switch used to clear any encoding (ZEROIZE) in the TSEC/ KY-58 system.
DELAY Switch	Two position toggle switch; DELAY position used when received signal is to be retransmitted.
PLAIN/C/RAD/ Switch	Two position rotary switch used to select TSEC/KY-58 operating mode. A third position (C/RAD 2)is covered and locked out.
PLAIN	Permits normal (unsecured) communications on associated FM radio set.
C-RAD1	Permits secured communications on associated FM radio set.
FILL Switch	Six position, rotary switch, used to select any of six storage registers for storage of crypto-net variable (CNV).
MODE Switch	Three position rotary used to select the operating/loading mode of the TSEC/KY-58.
OP	Allows normal operation of KY-58.
LD	Allows normal loading of CNV.
RV	Allows remote loading of CNV.
POWER ON Switch Position	Two position toggle switch used to apply power to TSEC/KY-58.

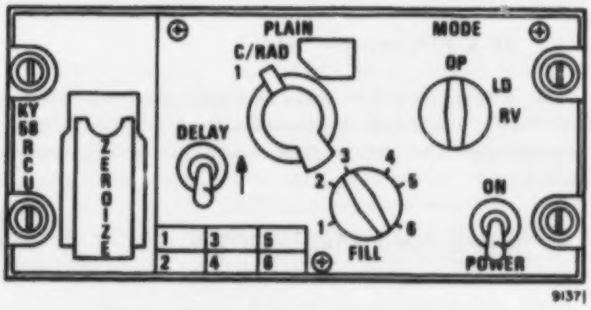


Figure 3-7. Remote Control Unit TSEC/KY-58 (Z-AHP)

3-18. *Normal Operation.*

a. Operating procedures for secure voice.

NOTE

To talk in secure voice, the KY-58 must be loaded with any number of desired variables.

1. Set the MODE switch to OP.

2. Set the FILL switch to the storage register which contains the required crypto-net variable (CNV).

3. Pull out and lift up the POWER switch to ON. A beeping tone and background 3 noise will be heard in the headset. Before the set can be used, the tone must be cleared by momentarily keying the No. 1 VHF AM/FM Radio with the PTT switch.

4. Set the PLAIN C/RAD1 switch to C/RAD1.

5. If the signal is to be retransmitted, pull out and lift up the DELAY switch to (ON).

6. Clear voice procedures: To operate in clear voice (plain text) simply:

(a) Set the PLAIN-C/RAD switch to PLAIN.

(b) Operate the equipment.

b. Zeroizing procedures.

NOTE

Instructions should originate from the net controller or commander as to when to zeroize the equipment.

1. Lift the red ZEROIZE switch cover.

2. Push the spring-loaded ZEROIZE switch up. This will zeroize positions 1-6.

3. Close the red cover. The equipment is now zeroized and secure voice communications are no longer possible.

c. Automatic remote keying procedures.

NOTE

Automatic remote keying (AK) causes an old crypto-net variable (CNV) to be replaced by a new CNV. Net controller simply transmits the new CNV to your KY-58.

1. The net controller will use a secure voice channel, with directions to stand-by for an AK transmission. Calls should not be made during this stand-by action.

2. Several beeps will be heard in the headset. This means that the old CNV is being replaced by a new CNV.

3. Using this new CNV, the net controller will ask for a radio check.

4. After the radio check is completed, the net controller instructions will be to resume normal communications. No action should be taken until the net controller requests a radio check.

d. Manual remote keying procedures. The net controller will make contact on a secure voice channel with instructions to stand by for a new crypto-net variable (CNV) by a manual remote keying (MK) action. Upon instructions from the net controller:

1. Set the FILL switch to position 6. Notify the net controller by radio, and stand by.

2. When notified by the net controller, set the MODE switch to RV (receive variable). Notify the net controller, and stand by.

3. When notified by the net controller, set the FILL switch to any storage position selected to receive the new CNV (may be unused or may contain the variable being replaced). Notify the net controller, and stand by.

NOTE

When performing step 3, the storage position (1 through 6) selected to receive the new CNV may be unused, or it may contain the variable which is being replaced.

4. Upon instructions from the net controller:

   (a) Listen for a beep on your headset.

(b) Wait two seconds.

(c) Set the MODE switch to OP.

(d) Confirm.

5. If the MK operation was successful, the net controller will now contact you via the new CNV.

6. If the MK operation was not successful, the net controller will contact you via clear voice (plain) transmission, with instructions to set your FILL selector switch to position 6, and stand by while the MK operation is repeated.

e. It is important to be familiar with certain KY-58 audio tones. Some tones indicate normal operation, while others indicate equipment malfunction. These tones are:

1. Continuous beeping, with background noise, is a cryptoalarm. This occurs when power is first applied to the KY-58, or when the KY-58 is zeroized. This beeping is part of normal KY-58 operation but must be cleared by momentarily keying the No. 1 VHF AM/FM Radio before communications can be achieved.

2. Background noise indicates that the KY-58 is working properly. This noise should occur at power on of the KY-58, and also when the KY-58 is generating a cryptovariable. If the background noise is not heard at power on, the equipment must be checked out by maintenance personnel.

3. Continuous tone could indicate a parity alarm. This will occur whenever an empty storage register is selected while holding the PTT button in. This tone can mean any of three conditions:

(a) Selection of an empty storage register.

(b) A bad cryptovariable is present.

(c) Equipment failure has occurred. To clear this tone, follow the loading procedures in TM 11-5810-262-0P. If this tone continues, have the equipment checked out by maintenance personnel.

4. Continuous tone could also indicate a cryptoalarm. If this tone occurs at any time other than in 3. above, equipment failure may have occurred. To clear this tone, repeat the loading procedures in TM 11-5810-262-0P. If this tone continues, have the equipment checked out by maintenance personnel.

5. Single beep, when Delay switch is up (time delay), can indicate any of three normal conditions:

(a) Each time the PTT button is pressed when the KY-58 is in C (cipher) and a filled storage register is selected, this tone will be heard. Normal use (speaking) of the KY-58 is possible.

(b) When the KY-58 has successfully received a cryptovariable, this tone indicates that a good cryptovariable is present in the selected register.

(c) When you begin to receive a transmission, this tone indicates that the received signal is in secure voice.

6. A single beep, when the Delay switch is up (time delay) occurring after the preamble is sent, indicates that you may begin speaking.

7. A single beep, followed by a burst of noise and a seemingly dead condition, indicates that your receiver is on a different variable than the distant transmitter. If this tone occurs when in C/RAD1: Turn FILL switch to the CNV, Plain-Cipher switch to PLAIN, and contact the transmitter in clear text and agree to meet on a particular variable.

3-19. HF Radio Set (AN/ARC-102).

The hf radio set (AN/ARC-102) provides communication in a 28-mHz high frequency band between 2.000 and 29.999 mHz. The primary operating mode of the hf radio set is the single sideband (ssb) mode. However, the set can transmit a compatible double side band amplitude-modulated (am) signal. Dc power to operate and control the hf radio set is supplied by the 28-volt No. 2 dc bus thru two HF circuit breakers on No. 2 power distribution panel. Ac power (115 volt) is from the No. 2 ac bus thru the HF circuit breaker on the No. 2 power distribution panel.

3-20. Controls and Function, HF Radio Set. (See fig. 3-8.)

CONTROL/ INDICATOR	FUNCTION
Mode Select Switch	Six position switch used to select radio operating mode.
OFF	Dc power is not applied to hf radio, set is inoperative.
USB	Radio transmits and receives in the upper side band (USB) mode.
LSB	Radio transmits and receives in the lower side band (LSB) mode.

NOTE

Both USB and LSB are classified as single side band (SSB) operation; however, both transmitting and receiving radios must be operating on the same side band for communications to occur.

CONTROL/ INDICATOR	FUNCTION
AM	Radio transmits and receives in the amplitude modulated (AM) mode.
DATA	Not used.
CW	Not used.
Frequency Controls	Four rotary controls used to select radio operating frequency.

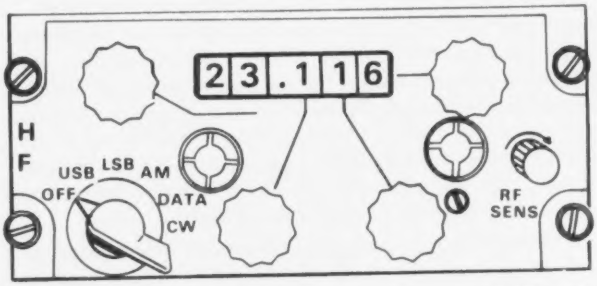


Figure 3-8. HF Radio Control

CONTROLS/ INDICATOR	FUNCTION
1-MHz Control	Twenty-eight (28) position control used to select first and second digit of operating frequency (from 2 to 29 MHz in 1 MHz steps).
01-MHz Control	Ten (10) position control used to select third digit of operating frequency (from 0.0 to 0.9 MHz in 0.1 MHz steps).
0.001-MHz Control	Ten (10) position control used to select fifth digit of operating frequency (from 0.000 to 0.009 MHz in 0.001 MHz steps).
Frequency Display	Five digit display used to display radio operating frequency.
RF SENS	Rotary control used to adjust radio receiver gain.

3-21. Normal Operation — HF Radio Set. The following steps provide hf set operating instructions.

a. Starting.

1. Interphone control panel — Set switches as follows:

(a) Receiver 4 switch — ON.

(b) Function select switch — 4.

2. Mode selector switch — AM, USB, or LSB.

3. Operating frequency — As required. If the mode selector switch was moved from OFF to an operating mode and the required operating frequency was already set, cycle the 1-kilohertz select knob one digit off frequency and after 8 seconds back to operating frequency. This will allow the receiver-transmitter to retune to the operating frequency.

4. Trigger switch — Press momentarily. Wait for the receiver-transmitter and antenna coupler units to tune. A 1,000-Hz tone will be heard in the headset until tuning is complete.

5. RF SENS control — Adjust so that the noise in the headset is barely audible.

b. Stopping. Mode selector switch — OFF.

SECTION III NAVIGATION EQUIPMENT

3-22. VHF NAVIGATION AND INSTRUMENT LANDING SYSTEM (AN/ARN-123).

The vhf navigation and instrument landing system (AN/ARN-123) is an integrated navigation receiver consisting of a 160-channel vor receiver, a 40-channel localizer receiver, a 40-channel glideslope receiver, and a marker beacon receiver. Each receiver operates independently. The system consists of a control panel on the console, a receiver on the avionics shelf, and four antennas on the fuselage. The set includes vor and marker beacon self-test capability.

a. Vor/Localizer Receiver. The vor/localizer receiver receives and processes signals over the frequency range between 108.00 and 117.95 mHz. The vor/localizer information is presented on the course deviation bar on the horizontal situation indicators on the pilot's and copilot's instrument panels. Vor bearing information is also displayed on No. 2 pointer of indicators. If the received signal is weak or the set malfunctions, a red NAV flag will appear on the indicator. The vor/localizer antenna is on the bottom of the helicopter at sta 79.

b. Glideslope Receiver. The glideslope receiver section of the AN/ARN-123 processes signals in the frequency range between 329.15 and 335.00 mHz. Glideslope information is displayed on the horizontal situation indicator on the pilot's and copilot's instrument panels. The set will also cause a red GS warning flag to appear on the indicators when the received signal is unreliable or the glideslope receiver malfunctions. The glideslope antenna is on the forward pylon above the windshield.

c. Marker Beacon Receiver. The marker beacon receiver is a fixed-frequency receiver (75 mHz) which receives signals from a ground marker beacon transmitter to determine helicopter position. The audio output of the marker beacon receiver is applied thru the interphone system to the headsets as a direct input (no interphone control box switch setting necessary) in conjunction with the audio output of the marker beacon. Three marker beacon lights are on each hsi mode select panel. The lights are labeled MKR BCN and indicate marker beacon passage. Also, specific tones will be heard over the interphone while flying over each beacon. Table 3-2 presents the indication as each beacon is passed. The lights are tested by momentarily pressing any one of three lights. The marker beacon antenna is under the fuselage forward of the forward cargo hook. Dc power to operate the set is from the 28 volt dc bus thru the VOR circuit breaker on No. 1 power distribution panel. Twenty-six-volt ac power is from the 26-volt ac instrument bus thru the VOR circuit breaker on No. 1 power distribution panel.

Table 3-2. Marker Beacon Indicator

BEACON	LIGHT COLOR	TONE (HERTZ)
Outer (O)	Blue	400
Middle (M)	Yellow	1300
Inner (I)	White	3000

3-23. Controls and Function, Vhf Navigation and Instrument Landing System Set. (See fig. 3-9.)

CONTROL/ INDICATOR	FUNCTION
NAV VOL	Provides power to set when turned from OFF. Turning knob clockwise increases volume.

CONTROLS/ INDICATOR	FUNCTION
VOR/MB TEST	Switch spring-loaded from TEST position. At TEST, the marker beacon lights come on.
Megahertz Select Knob	Left frequency select knob sets second and third digits of frequency in one megahertz steps.
Kilohertz Select Knob	Selects last two digits of frequency in 50-kilohertz increments.
MB VOL	Adjusts audio output level of marker beacon receiver. Provides power to the marker beacon when turned from OFF.
MB SENS	Marked HI and LO. LO sensitivity is used for positive identification of marker beacon passage. HI is used for station passage identification at the outer marker or enroute.
Marker Beacon Indicator Lights	Three lights marked O, M, and I on both hsi mode select panels. Lights come on when passing over beacons.

3-24. Normal Operation — Vhf Navigation and Instrument Landing System. (See fig. 3-9.) The following paragraphs provide navigation radio set operating procedures.

a. Starting:

1. Interphone AUX switch — ON.
2. NAV VOL switch — ON.

b. VOR/Localizer/ILS operation.

1. Megahertz and kilohertz selector — Set frequency of facility.
2. VOR SEL switch on hsi mode select panel — press. Check SEL light lit.
3. VOR ADF switch on hsi mode select panel — press, if VOR segment is not lit.
4. Volume control — Adjust. Identify facility.
5. Horizontal situation indicators — check for correct indications.

c. Marker Beacon Operation.

1. MB VOL switch — ON.
2. MB SENS — HI for enroute. LO for approach.
3. BEACON lamps on hsi panels — check lit at corresponding station passage.

d. Stopping — NAV VOL and MB VOL switches — OFF.

3-25. Direction Finder Set (AN/ARN-89).

Direction finder set (AN/ARN-89) is an airborne automatic direction finder (adf) operating within the frequency range of 100 to 3,000 kHz. The equipment provides visual and aural facilities for adf homing and position fixing. It is used as a navigational radio aid to continuously and visually indicate the magnetic bearing of a radio station while providing aural reception. The bearing of a radio station is displayed on the No. 2 bearing pointer on the hsi. Power for the direction-finder set is provided by the 28-volt No. 1 dc bus and the 26-volt ac instrument bus thru two ADF circuit breakers on No. 1 power distribution panel.

3-26. Controls and Function, Direction Finder Set (AN/ARN-89). (See fig. 3-10.)

CONTROLS/ INDICATOR	FUNCTION
Mode Switch OFF	OFF position deenergizes the direction finder set.
COMP	COMP position selects automatic direction finding.
ANT	ANT position permits reception for radio navigation or as a broadcast receiver.
LOOP	LOOP position, used in conjunction with LOOP switch, permits aural null homing and manual direction finding.

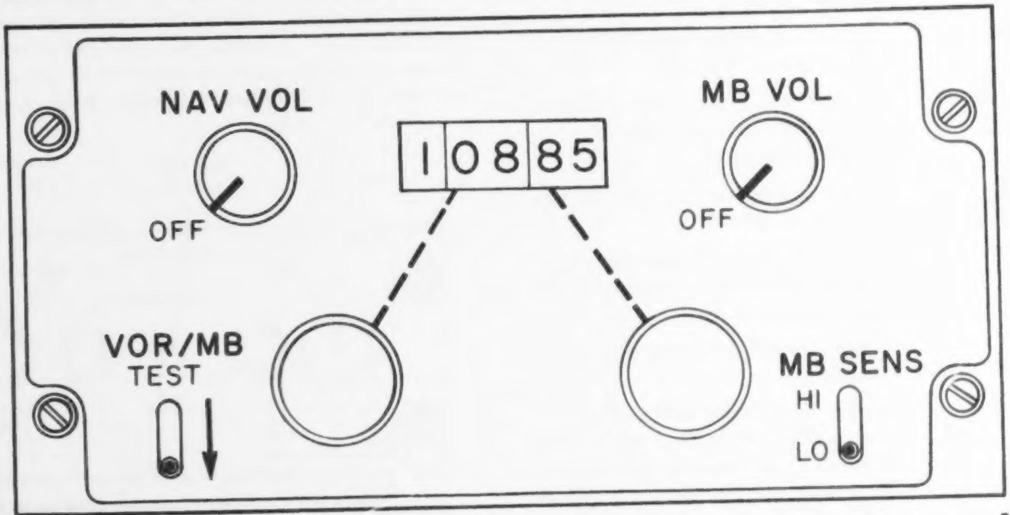


Figure 3-9. Vhf Navigation and Instrument Landing System Control (AN/ARN-123)

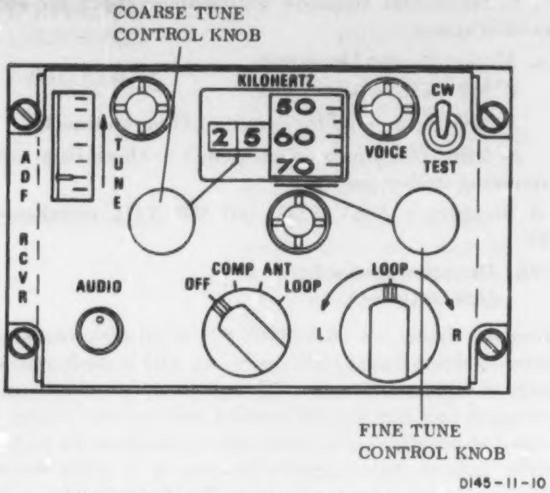


Figure 3-10. Direction Finder Control

CONTROLS/ INDICATOR	FUNCTION
AUDIO Control	Adjusts audio level in COMP position. Used as rf gain control in LOOP or ANT position.
LOOP Switch	When function switch is set to LOOP, LOOP switch enables manual rotation of adf loop antenna and bearing indicator pointer left or right for manual direction finding, or when homing to a radio station. Returning LOOP switch to center position stops rotation of bearing indicator pointer at any desired position.
Coarse Tune Control	Tunes receiver in 100 kHz steps as indicated by first two digits of KILO HERTZ indicator
Fine Tune Control	Provides selection of 10 kHz digits (continuous tuning) as indicated by last two digits of KILO HERTZ indicator.
KILO HERTZ Indicator	Displays operating frequency to which receiver is tuned.
TUNE Meter	Provides indication of relative signal strength while tuning receiver to specific radio signal.
CW-VOICE-TEST Switch	Three position toggle switch. Spring loaded from TEST.
CW	Enables the beat frequency oscillator (bfo) to permit tuning to continuous wave stations.
VOICE	Enables the set to operate as an am receiver.
TEST	Rotates the bearing indicator approximately 180° to check operation of the set. The TEST switch functions when the function switch is at COMP only.

3-27. Normal Operation — Direction Finder Set. The following paragraphs discuss adf set operation.

a. Starting.

1. Interphone control panel — Receivers NAV switch — ON.

2. Mode switch — COMP.

3. CW-VOICE-TEST — CW or VOICE.

4. Tune controls — set frequency. Tune for maximum signal strength on the tuning meter.

5. AUDIO control — adjust.

b. Adf Operation.

1. VOR ADF switch on HSI mode select panel — press, if ADF segment not lit.

2. Check for the correct bearing indication, on hsi No. 2 bearing pointer.

c. Radio Receiver Operation.

1. Function switch — ANT.

2. Tune control — set frequency; then tune for maximum signal strength on the tuning meter.

d. Aural Null.

1. CW-VOICE-TEST switch — CW.

2. Function switch — LOOP.

3. LOOP switch — Rotate for audio and tune indicator null. Release switch. Observe bearing to station on indicators. Two null positions, 180° apart, may be obtained.

3-28. Gyromatic Compass Set (AN/ASN-43).

The gyromagnetic compass set (fig. 3-11) is a direction sensing system which provides a visual indication of the heading of the helicopter with respect to the earths magnetic field or referenced to a free directional gyro. Heading information is displayed on both horizontal situation indicators. The display is used in navigation to maintain flight path direction. Also, any heading selected with the heading bug on either horizontal situation indicator can be automatically maintained by the advanced flight control system. Ac power (115-volt) to operate the system is supplied by the No. 1 ac bus thru the CMPS circuit breaker; twenty-six volt ac power is supplied by the ac instrument bus thru the CMPS circuit breaker. Both circuit breakers are on the No. 1 pdp.

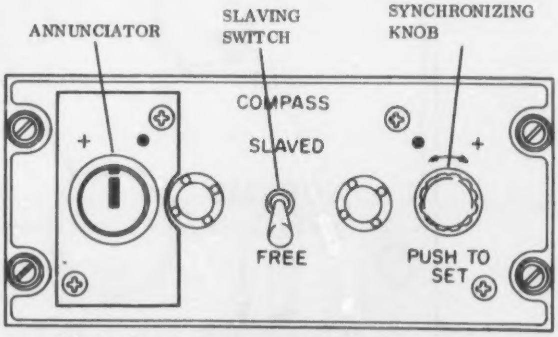


Figure 3-11. Gyromagnetic Compass Set Control Panel

3-29. Controls and Function, Gyromagnetic Compass Set (AN/ASN-43). (See fig. 3-11 and 3-12.)

CONTROLS/ INDICATOR	FUNCTION
LATITUDE Switch	Two-position switch on directional gyro on avionics shelf. This switch is used to correct for gyro precession for the hemisphere of operation: N for northern hemisphere, S for southern hemisphere.
LATITUDE Control Switch	Rotary control on directional gyro labeled 0 to 90. It is used to set the local latitude into the directional gyro for free gyro operation.
SLAVED-FREE Switch	On compass control panel. (See fig. 3-11.) When switch is at SLAVED, the compass cards on both horizontal situation indicators are slaved to the output of the remote compass and stabilized by the directional gyro. At FREE, the cards are referenced to the directional gyro only and act as turn indicators. FREE is used primarily in polar regions where magnetic indications may be unreliable.
Annunciator	Indicates misalignment of compass cards and gyro-compass when pointer is not centered.
Synchronizing knob (PUSH TO SET)	Rotated in (−) or (+) direction as indicated by annunciator pointer to align compass cards with gyro-compass.
HDG Flag	A red flag on both hsi's indicates failure of the gyromagnetic compass system when displayed.

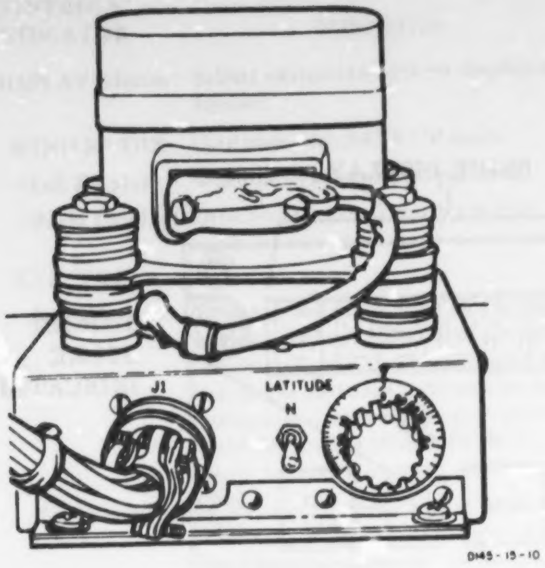


Figure 3-12. Directional Gyro (CN-998/ASN-43)

3-30. *Operating Procedures — Gyromagnetic Compass Set.* (See fig. 3-11.)

a. Slaved Gyro Operation. With compass slaving switch at SLAVED, the system operates in the slaved mode and the directional gyro processes to align the compass cards on the hsi's with the magnetic heading of the helicopter. During the first 2 minutes after power is applied, the system operates in a fast slave mode while the gyro attains its speed. After this initial alignment period is complete, the gyromagnetic compass will return to the normal slaved mode. During this mode of operation, the compass cards will remain aligned with the magnetic heading of the helicopter. The annunciator pointer will occassionally point to a dot or a cross indicating that corrections are automatically being made.

b. Free Directional Gyro Operation. If the compass slaving switch is at FREE, the system operates in the free directional mode. In this mode, the compass cards can be set to any heading by pressing the synchronization knob and turning it until the cards reach the selected setting. Normally, the free directional gyro mode is employed only in polar regions of the earth where magnetic references are unreliable. However, it can be useful if the slaving system malfunctions. For proper operation, the latitude controls on the directional gyro must be set to the local latitude.

c. Manual Synchronization. If power has been applied to the system with the compass slaving switch at FREE, or if the system has been operated in the free directional gyro mode for a period of time, the compass cards will not be aligned with the magnetic heading of the helicopter. The system can be reset to the correct magnetic heading by pushing and turning the synchronization knob in the direction of the symbol indicated by the annunciator pointer until the pointer is centered. If the slaving switch is then set to SLAVED, the compass cards will maintain correct magnetic heading.

3-31. Doppler Navigation Set (AN/ASN-128).

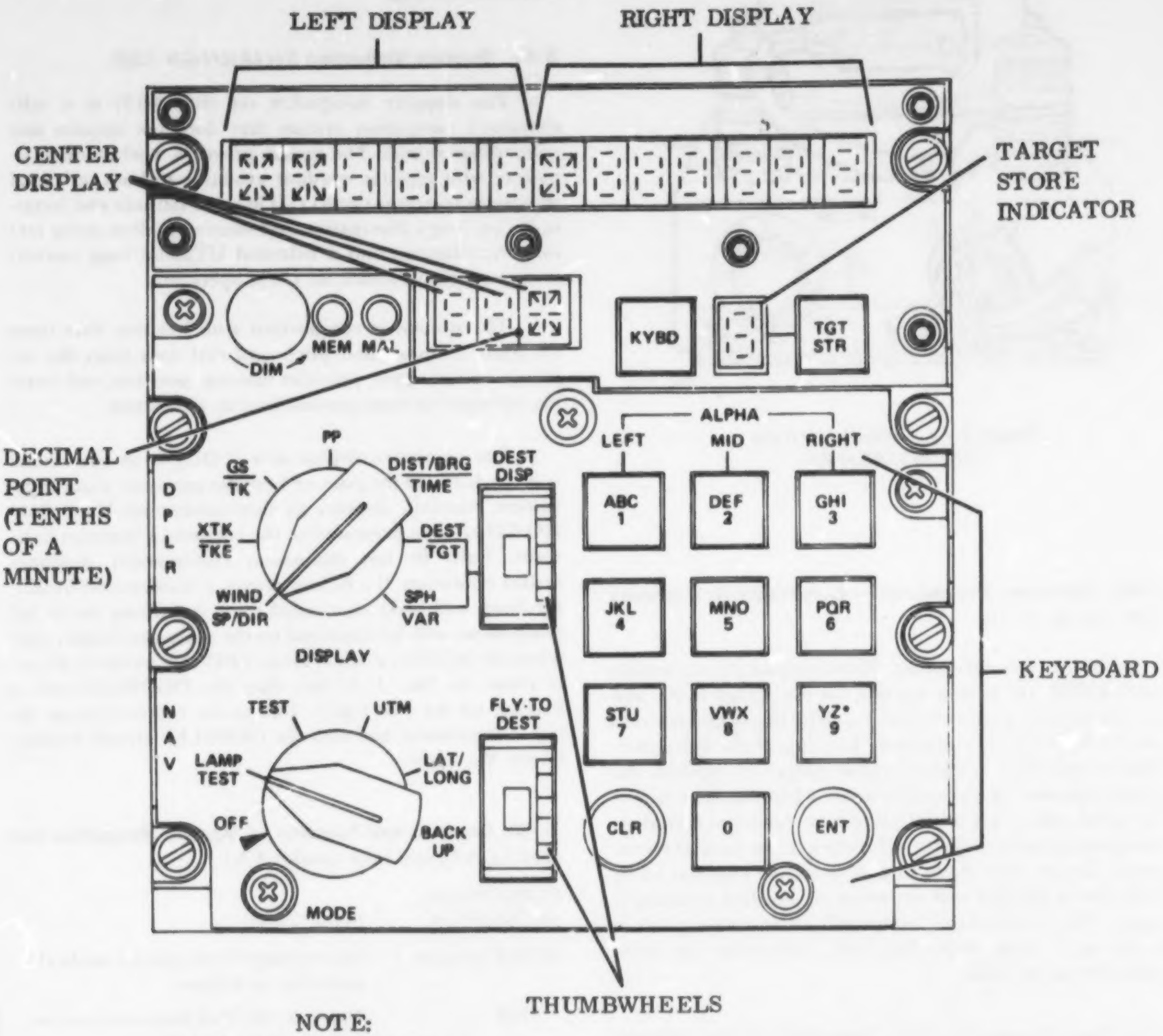
a. The doppler navigation set (fig. 3-13) is a self-contained navigation system that does not require any ground-based aids. The system provides worldwide navigation, with position readout available in both universal transverse mercator (grid) (UTM) and latitude and longitude (lat/long). Navigation and steering is done using lat/long coordinates, and a bilateral UTM-lat/long conversion routine is provided for UTM operation.

b. The system, in conjunction with heading data from the gyro compass, and pitch and roll data from the copilot's attitude gyro, provides velocity, position, and steering information from ground level to 10,000 feet.

c. The computer-display unit (CDU) is on the canted console, between the pilot and copilot positions. Course deviation, bearing, distance to destination and NAV GO/NO GO are also presented on the horizontal situation indicator. Built in test equipment continuously monitors system operation. If a failure occurs, a malfunction indicator lamp will light and coded data, indicating the failed component, will be displayed on the computer display unit when the MODE switch is set to TEST. Dc power to the set is from the No. 2 dc bus thru the DOPPLER circuit breaker on the No. 2 pdp. Twenty-six volt ac is from the No. 1 instrument bus thru the DOPPLER circuit breaker on the No. 1 pdp.

3-32. *Controls and Function — Doppler Navigation Set.* (See fig. 3-13 and refer to table 3-3.)

CONTROLS/ INDICATOR	FUNCTION
MODE Selector	Selects doppler navigation mode of operation as follows:
OFF	Turns set off. Pull knob out to move from or to this position.
LAMP TEST	Checks operation of all lamps and lamp segments.
TEST	Initiates built-in test for set. System reverts to backup navigation operation during this mode.
UTM	Selects universal transverse mercator coordinate system for display and insertion of information.
LAT/LONG	Select latitude/longitude coordinate system for display and insertion of information.
BACKUP	Places set in remembered velocity mode of operation.


LEFT DISPLAY
RIGHT DISPLAY
CENTER DISPLAY
TARGET STORE INDICATOR
DECIMAL POINT (TENTHS OF A MINUTE)
KEYBOARD
THUMBWHEELS
DIM
MEM
MAL
KYBD
TGT STR
ALPHA
LEFT
MID
RIGHT
ABC 1
DEF 2
GHI 3
JKL 4
MNO 5
PQR 6
STU 7
VWX 8
YZ* 9
CLR
0
ENT
PP
GS TK
DIST/BRG TIME
DEST DISP
D P L R
XTK TKE
DEST TGT
WIND SP/DIR
SPH VAR
DISPLAY
N A V
TEST
UTM
LAMP TEST
LAT/LONG
OFF
BACK UP
FLY-TO DEST
MODE

NOTE:
DISPLAYS SHOWN WITH
MODE SWITCH AT LAMP TEST.

Figure 3-13. Doppler Navigation Set Control (AN/ASN-128)

CONTROLS/ INDICATOR	FUNCTION
DISPLAY selector	Selects navigation data for display as follows:
WIND SP/DIR	Used only with BACKUP mode.
(Left Display)	Windspeed kilometer(s) per hour.
(Right Display)	Direction (degrees) relative to true north.
XTK/TKE	
(Left Display)	Distance crosstrack error (XTK) in km and tenths of a km left of aircraft. Track error will also be displayed by the course deviation indicator on the horizontal situation indicator when DOP SEL on the MODE SELECT panel is depressed.
(Right Display)	Track angle error (TKE) in degrees and right or left of present aircraft heading.
GS/TK	
(Left Display)	Groundspeed (GS) in km/hr.
(Right Display)	Track angle in degrees relative to true north.
PP with mode switch set to UTM	
(Center Display)	Present position UTM zone.
(Left Display)	Present position UTM square designator and easting in km to nearest 10 meters.
(Right Display)	Present position UTM northing in km to nearest 10 meters.
PP with MODE switch set to LAT/LONG	
(Left Display)	Present latitude position in degrees, minutes, and tenths of minutes.
(Right Display)	Present longitude position in degrees, minutes, and tenths of minutes.
DEST/BRG/ TIME	
(Center Display)	Time to the destination set on FLY-TO DEST thumbwheel in minutes and tenths of minutes.
(Left Display)	Distance to the destination set on FLY-TO DEST thumbwheel in km and tenths of a km.
(Right Display)	Bearing to the destination set on FLY-TO DEST thumbwheel in degrees. Bearing is also indicated by the No. 1 bearing pointer on both horizontal situation indicators.
DEST/TGT	
(Center Display)	UTM zone of destination set on DEST DISP thumbwheel.
(Left Display)	UTM square designator, and easting or latitude (N 84° to S 80° approx) of destination set on DEST DISP thumbwheel.
(Right Display)	UTM northing or Longitude of destination set on DEST DISP thumbwheel.
SPH/VAR	
(Left Display)	Spheroid code of destination set on DEST DISP thumbwheel.
(Right Display)	Magnetic variation (in degrees and tenths of degrees) of destination set on DEST DISP thumbwheel.
MAL Indicator Lamp	Lights when set malfunctions. In case of an intermittent malfunction, system may operate correctly, but must be cycled to OFF and then to on to put MAL light off.
MEM Indicator Lamp	Lights when radar portion of set is not tracking. May occur over smooth water.
DIM Control	Controls light intensity of display characters.
Left, Right, and Center Display Lamp	Alphanumeric and numeric characters that display data, as determined by setting of DISPLAY switch, mode switch, and keyboard.
Target Storage Indicator	Displays destination number (memory location) in which present position will be stored when TGT STR pushbutton is pressed.
TGT STR Pushbutton	Stores present position data when pressed.
KYBD Pushbutton	Used in conjunction with keyboard to allow data entry. KYBD pushbutton is always lighted when system is on.
DEST DISP Thumbwheel Switch	Destination display thumbwheel switch is used along with DEST/TGT and SPH/VAR position of DISPLAY switch to select destination whose coordinates or magnetic variation to be displayed or entered. Destinations are 0 through 9, P (present position) and H (home).
Keyboard	Used to enter data into system. Keys set up data on display. ENT key enters display data into system. CLR key, when pressed once, clears last characters entered on display. When pressed twice, this key clears display under control. All resulting actions are initiated upon release of the key.

FLY-TO-DEST Thumbwheel Switch	Selects destination to which steering information is desired. Destinations are 0 through 9, P (present position) and H (home).
ENT Key	Enters data set up on keyboard into memory when pressed.
CLR Key	Clears last entered character when pressed once. When pressed twice, clears entire display panel under keyboard control.

3-33. thru 3-37. Deleted.

Table 3-3. Computer-Display Unit Data Displays

	CENTER DISPLAY		LEFT DISPLAY		RIGHT DISPLAY	
SWITCH POSITION	DATA	RANGE	DATA	RANGE	DATA	RANGE
WIND SP/DIR			Windspeed	999 km/h	Wind Direction	359°
XTK/TKE			Crosstrack Distance Error	L/R 999.9 km	Track Angle Error	R/L 180°
GS/TK			Groundspeed	999 km/h	Track	359°
PP UTM	UTM Zone	Note 2	Area/Easting	WV9999	Northing	9999
LAT/LONG			Latitude	N 84°00.0" S 80°00.0"	Longitude	E/W 180°00.0"
DIST/BRG/TIME	Time	99.9 Min.	Distance to Go.	999.9 km	Bearing	359°
DEST/TGT UTM	UTM Zone	Note 2	Area/Easting	WV9999 Note 3	Northing	9999
LAT/LONG			Latitude	N 84°00.0" S 80°00.0"	Longitude	E/W 180°00.0"
SPH/VAR			Spheroid	Note 1	Variation Note 4	E/W 180°

NOTES:

1. See table 3-4 for spheroid data codes and covered areas.
2. Numeric: 01-60.
   Alpha: C-X, except I and O.
3. Typical 100 km Designator:
   Column Designator: A-Z, except I and O.
   Row Designator: A-V, except I and O.
4. Variation displayed is for destination indicated by DEST DISP thumbwheel.

3-38. Display and Keyboard Operation.

In LAT/LONG coordinates, the two fields of control are the left and right displays. In UTM coordinates, the first field of control is the center display and the second field is the combination of the left and right displays. When pressing the KYBD pushbutton, one or other of the fields described above is under control. If it is not desired to change the information in the field under control, the pilot can advance to the next field of the display panel by pressing the KYBD pushbutton again. The last character entered may be cleared by pressing the CLR key. That character may be a symbol or an alphanumeric character. However, if the CLR key is pressed twice in succession, all characters in the field under control will be cleared and that field will still remain under control.

3-39. Data Entry.

To enter a number, press the corresponding key. To enter a letter, first press the key corresponding to the desired letter. Then press a key in the LEFT, MID, or RIGHT column corresponding to the position of the letter on the pushbutton.

Example: To enter an L, first press L, then either 3, 6, or 9 in the RIGHT column. The computer program is designed to reject unacceptable data (for example, a UTM area of WI does not exist, and will be rejected). If the operator attempts to insert unacceptable data, the display will be blank after ENT is pressed.

3-40. Starting Procedure.

a. MODE selector — LAMP TEST. All lights and lamp segments should be lit.

(1) Left, right, center and target storage indicator — Lit (fig. 3-12). All other lights should be on.

(2) Turn DIM control fully clockwise, then fully counterclockwise, and return to full clockwise; all segments of the display should alternately glow brightly, go off, and then glow brightly.

b. MODE selector — TEST. After about 15 seconds, left display should display GO. Ignore the random display of alpha and numeric characters which occurs during the first 15 seconds. Also ignore test velocity and angle data displayed after the display has frozen. After about 15 seconds, one of the following five displays will be observed in the first two character positions in the left display.

NOTE

If the MAL lamp lights during any mode of operation except LAMP TEST, the computer-display unit MODE switch should be set to OFF, and then to TEST, to verify the failure. If the MAL lamp remains on at TEST, notify maintenance.

DISPLAY		REMARKS
LEFT	RIGHT	
GO	Display blanks	System is operating satisfactorily.
GO	P	If right display is P, then pitch or roll data is missing or in error. In this case, pitch and roll in the computer are both set to zero and navigation is degraded. Problem may be in the vertical gyroscope or helicopter wiring.

NOTE

If the TEST mode display is MN or NG, the MODE switch should be recycled through OFF to verify that the failure is not a momentary one. If the TEST mode display is MN, the data entry may be made in the UTM or LAT/LONG mode, but any navigation must be carried on with the system in the BACKUP mode.

LEFT	RIGHT	REMARKS
BU	C, R, S, or H followed by a numeric code	A failure has occurred and the system has automatically switched to a BACKUP mode of operation using last remembered velocities for navigation. The operator can, as an option, enter his best estimate of ground speed and track angle.
.MN	C, R, S, or H followed by a numeric code	A failure has occurred and the BACKUP mode used for manual navigation (MN), is the only means of valid navigation. The operator may use the computer as a dead reckoning device by entering ground speed and track data. The operator should update present position as soon as possible, because it is possible significant navigation errors may have accumulated.
NG	C, R, S, or H followed by a numeric code	A failure has occurred in the system and the operator should not use the system.
EN		The 9V battery has failed. The system will still operate but all stored data will be lost when set is turned off. Data must be re-entered.
Random display	Random display	A failure occurred and the operator should not use the system.

3-41. Entering Data.

This initial data is inserted before navigating with the doppler.

a. Spheroid of operation, when using UTM coordinates.

b. UTM or LAT/LONG coordinates of present position.

c. Magnetic Variation (MAG VAR) of present position.

d. Coordinates of desired destination — 0 through 5 and H: (6 through 9 are normally used for target store locations: but may also be used for destinations). It is not necessary to enter all destinations in the same coordinate system.

NOTE

It is not necessary to enter destinations unless steering information is required, unless it is desired to update present position by overflying a destination, or unless a present position MAG VAR computation is desired. If a present position MAG VAR running update is desired, destination MAG VAR must be entered. The operator may enter one or more destination variations to effect the variation update; it is not necessary for all destinations to have associated MAG VAR entered.

e. Variations of destinations.

3-42. Entering Spheroid and/or Variation.

a. MODE selector — UTM, LAT/LONG or BACKUP.

b. DISPLAY selector — SPH-VAR.

c. DEST DISP thumbwheel — P, numeral, or H as desired.

d. KYBD pushbutton — Press. Observe display freezes and TGT STR indicator blanks. Press KYBD pushbutton again and observe left display blanks. If no spheroid data is to be entered, KYBD pushbutton — Press again, go to step g.

e. Spheroid data — Entry. (Example: IN0). Press keys 3, 3, 5, 5 and 0. Left display should indicate IN0. Refer to Table 3-4 for codes.

f. ENT key — Press if no variation data is to be entered.

g. KYBD pushbutton — Press, if variation data is to be entered, and note right display blanks. (If no variation data is to be entered, ENT key — Press.)

h. Variation data — Enter. (Example: E001.2, press keyboard keys 2, 2, 0, 0, 1 and 2. Press ENT key, the entire display will blank and TGT STR number will reappear, display should indicate INO E001.2.)

Table 3-4. Spheroid Data Codes

SPHEROID	CODE	AREA COVERED
CLARKE 1866	CL6	United States north through North Pole
CLARKE 1880	CL0	Africa west through Algeria
INTERNATIONAL	IN0	All of Europe, Saudi Arabia, Greenland, South America, Indian Ocean, Pacific Ocean, and Atlantic Ocean
BESSEL	BE0	Indonesia, Manchuria, to Eastern Russia
EVEREST	EV0	Mt. Everest, India, and Pakistan
AUSTRALIAN NATIONAL	AU0	Australia

NOTE

If operation is to occur in a region with relatively constant variation, the operator enters variation only for present position, and the computer will use this value throughout the flight.

3-43. Entering Present Position or Destination in UTM.

The variation of a destination must be entered after the associated destination coordinates are entered, since each time a destination is entered its associated variation is deleted. The order of entry for present position is irrelevant.

a. MODE selector — UTM.

b. DISPLAY selector — DEST-TGT.

c. DEST DISP thumbwheel — P, numeral, or H as desired.

d. Present position and destination — Enter. (Example: Entry of zone 31T, area CF, easting 0958 and northing 3849).

(1) KYBD pushbutton — Press. Observe that display freeze and TGT STR indicator blanks.

(2) KYBD pushbutton — Press. Observe that center display blanks.

(3) Key 3, 1, 7, and 8 — Press.

(4) KYBD button — Press. Observe left and right displays blank.

(5) Key 1, 3, 2, 3, 0, 9, 5, 8, 3, 8, 4, 9 — Press.

(6) ENT key — Press. Left, right, and center displays will momentarily blank and then display CF 0958, 3849, 31T, respectively. TGT STR number will appear.

3-44. Entering Present Position or Destination in LAT/LONG.

The variation of a destination must be entered after the associated destination coordinates are entered, since each time a destination is entered its associated variation is deleted. The order of entry for present position is irrelevant.

a. MODE selector — LAT/LONG.

b. DISPLAY selector — DEST-TGT.

c. DEST DISP thumbwheel — P, numeral or H as desired.

d. Present position or destination — Enter. (Example: Entry of N41° 10.1 minutes and E035° 50.2 minutes.)

(1) KYBD pushbutton — Press. Observe that display freezes and TGT STR indicator blanks.

(2) KYBD pushbutton — Press. Observe that left display blanks.

(3) Key 5, 5, 4.1, 1, 0, and 1 — Press.

(4) KYBD pushbutton — Press. Observe right display blank.

(5) Key 2, 2, 0, 3, 5, 5, 0, and 2 — Press.

(6) ENT key — Press. Left, right, and center displays will momentatily blank and TGT STR number will reappear. Displays should indicate N41° 10.1 EO 35° 50.2.

3-45. Entering Ground Speed and Track.

a. MODE selector — BACK UP.

b. DISPLAY selector — GS-TK.

c. Ground speed and track — Enter. (Example: Enter 131 km/h and 024°. Press KYBD pushbutton, observe that left display freezes and TGT STR indicator blanks. Press KYBD pushbutton and observe that left display blanks. Press keys 1, 3, and 1. Left display indicates 131. Press KYBD pushbutton, control shifts to right display, and right display blanks. Press keys 0, 2 and 4.)

d. ENT key — Press. The entire display will blank, and TGT STR number will reappear. Display should indicate 131 024°.

3-46. Initial Data Entry.

After initial data has been entered, system initialization should be performed.

a. Present position variation — Enter.

b. DISPLAY selector — DEST-TGT.

c. DEST DISP thumbwheel — P. Do not press ENT key now.

d. ENT key — Press as helicopter is sitting over or overflies initial fix position.

e. FLY-TO DEST thumbwheel — Desired destination location. The computer calculates a course between the destination and the helicopter position at the time the destination was selected.

3-47. Update of Present Position from Stored Destination.

a. FLY-TO DEST Thumbwheel — Set to destination to be overflown.

b. DISPLAY selector — DIST/BRG-TIME.

c. KYBD pushbutton — Press and release when helicopter is over the destination. Display freezes upon release of the pushbutton.

NOTE

If a present position update is not desired, as indicated by an appropriately small value of distance to go on overflying the destination, set the DISPLAY selector to some other position; this aborts the update mode.

d. ENT key — Press.

3-48. Update of Present Position from Landmark.

There are two methods for updating present position from a landmark. Method 1 is useful if the landmark comes up unexpectedly and the operator needs time to determine the coordinates. Method 2 is used when a landmark update is anticipated.

a. Method 1.

(1) DISPLAY selector — PP.

(2) KYBD pushbutton — Press as landmark is overflown. Present position display will freeze upon release of pushbutton.

(3) Compare landmark coordinates with those on display.

(4) Landmark coordinates — Enter. If difference warrants an update.

(5) ENT key — Press if update is required.

(6) DISPLAY selector — Set to some other position to abort update.

b. Method 2.

(1) DISPLAY selector — DEST/TGT.

(2) DEST DISP thumbwheel — P. Present position coordinates should be displayed.

(3) KYBD pushbutton — Press, observe that display freezes.

(4) Landmark coordinates — Manually enter via keyboard.

(5) ENT key — Press when overflying landmark.

(6) DISPLAY selector — Set to some other position to abort update.

3-49. Left-Right Steering Signals.

Flying shortest distance to destination from present position:

a. Select desired destination with FLY-TO DEST thumbwheel.

NOTE

If the desired destination is already selected but an updated course is needed, then the FLY-TO DEST thumbwheel must be cycled to another destination and back so the computer will recalculate the new course.

b. Hsi — Fly helicopter in direction of No. 1 bearing pointer on hsi to center the bar. The No. 1 bearing pointer will display relative bearing to doppler destination set on FLY-TO-DEST thumbwheel.

c. DISPLAY Selector — XTK/TKE.

3-50. *Target Store (TGT STR) Operation.*

Two methods may be used for target store operation. Method 1 is normally used when time is not available for preplanning a target store operation. Method 2 is used when time is available and it is desired to store a target in a specific DEST DISP position.

a. Method 1.

(1) TGT STR pushbutton — Press when flying over target.

(2) Present position at the time the pushbutton is released is automatically stored and the destination location is that which was displayed in the target store indicator (position 6, 7, 8 or 9) immediately before pressing the TGT STR pushbutton.

b. Method 2.

(1) MODE selector — UMT or LAT/LONG, depending on coordinate format desired.

(2) DISPLAY selector — DEST/TGT.

(3) DEST DISP thumbwheel — P.

(4) KYBD pushbutton — Press when over flying potential target. Display should freeze.

NOTE

Do not press ENT key while DEST DISP thumbwheel is at P.

(5) If it is desired to store the target, turn DEST DISP thumbwheel to destination location desired and press ENT key.

(6) If it is not desired to store the target, place DISPLAY selector momentarily to another position.

3-51. *Transferring Stored Target Coordinates from One Location to Another.*

The following procedure allows the operator to transfer stored target coordinates from one thumbwheel location to another. For example, it is assumed that the pilot wants to put the coordinates of stored target 7 into location of destination 2.

NOTE

Throughout this procedure, range, time-to-go, bearing and left/right steering data are computed and displayed for the destination selected via the FLY-TO DEST thumbwheel.

a. DISPLAY selector — DEST/TGT.
b. DEST DISP thumbwheel — 7.
c. KYBD pushbutton — Press.
d. DEST DISP thumbwheel — 2.
e. ENT key — Press.

3-52. *Transferring Variation from One Location to Another.*

The procedure to transfer variation data to the same location where the associated stored target coordinates has been transferred is the same as in para 3-50, Transferring Stored Target Coordinates from One Location to Another, except that the DISPLAY selector is placed at SPH/VAR.

3-53. *Dead Reckoning Navigation.*

As a BACKUP mode, dead reckoning navigation can be done using ground speed and track angle estimates provided by the operator.

a. MODE selector — BACKUP.

b. DISPLAY selector — GS/TK.

c. Best estimate of ground speed and track angle — Enter via keyboard.

d. Set MODE selector to any other position to abort this mode.

3-54. *Operation During and after Power Interruption.*

During a dc power interruption inflight, or when all helicopter power is removed, the random access memory (RAM) (stored destination and present position) data is retained by power from an 8.4 volt dc dry cell battery. This makes it unnecessary to reenter any navigational data when power returns or before each flight. If the battery does not retain the stored destination data during power interruption, the display will indicate an EN when power returns. This indicates to the pilot that previously stored data has been lost, and that present position, spheroid/variation, and destinations must be entered. The computer, upon return of power, resets present position variation to E000.0, destination and associated variations to a non-entered state, sets wind to zero and spheroid to CL6. The following data must be entered following battery failure:

a. Spheroid.
b. Present position variation.
c. Present position.
d. Each destination and its associated variation.

3-55. Stopping Procedure.

MODE selector — OFF.

3-56. Horizontal Situation Indicator (ID2103).

Two horizontal situation indicators (fig. 3-14) (hsi) one on each pilots' instrument panel are installed. Each indicator can display helicopter heading, FM homing, and position relative to a selected course or bearing. Also, during an ILS approach, the indicator displays helicopter position relative to the glide slope and localizer. The automatic heading select feature of the advanced flight control system is also controlled through the hsi. Selection of navigational equipment to be displayed on each hsi is controlled through the HSI MODE SELECT panel on each instrument panel below each hsi. Each hsi receives electrical power from three different sources (copilots sources are in parentheses): 28 volts dc from the No. 2 (No. 1) dc bus through the PLT (COPLT) HSI MODE SEL circuit breaker, 115 volts ac from the No. 2 (No. 1) ac bus through the PLT (COPLT) HSI circuit breaker, and 26 volts ac from the No. 2 (No. 1) instrument bus through the PLT (COPLT) HSI circuit breaker.

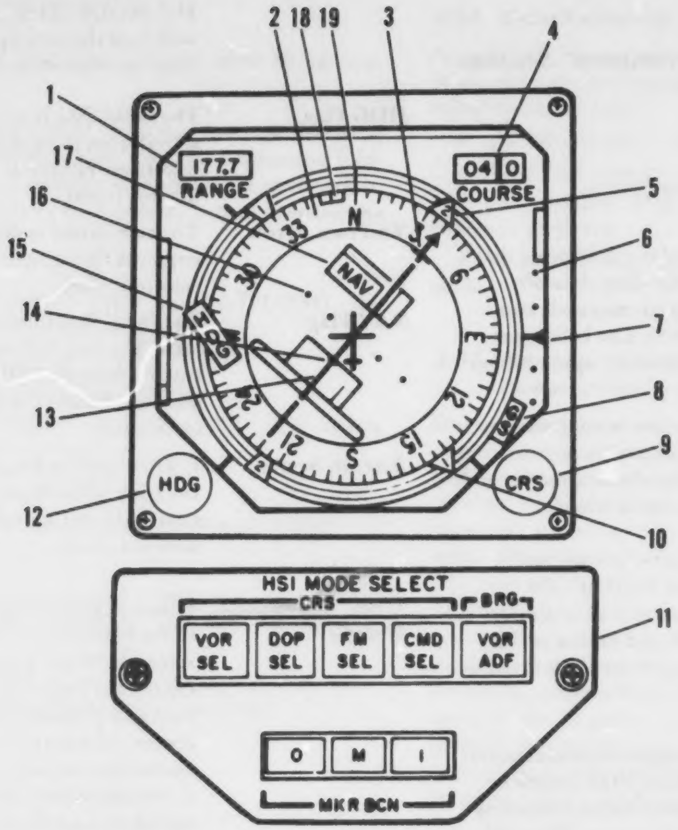
3-57. Controls and Indicators — Horizontal Situation Indicators (ID-2103). (See fig. 3-14.)

CONTROLS/ INDICATOR	FUNCTION
Compass Card	The compass card is a 360° scale that turns to display heading data obtained from the gyro magnetic compass (AN/ASN-43). The helicopter headings are read at the upper lubber line.
Bearing Pointer No. 1	The pointer operates in conjunction with doppler. Indicates magnetic bearing to doppler destination set on FLY-TO-DEST thumbwheel.
Bearing Pointer No. 2	The pointer operates in conjunction with selected VOR or ADF receiver. The pointer is read against the compass card and indicates the magnetic bearing to the VOR or ADF station.
Course Deviation Indicator	This indicator indicates lateral deviation from a selected VOR course or doppler computed course or heading in the case of FM homing. When the helicopter is flying to correct course, the course indicator will be aligned with the course pointer and will be centered on the fixed aircraft symbol. The two dots on either side of the indicator indicate amount of course deviation. One dot displacement is equivalent to 5° off VOR or doppler and 1¼ degree off localizer course. These displacements do not apply to FM homing.
CRS Knob Course Indicator Course Pointer	Course select (CRS) knob and the COURSE indicator operate in conjunction with the course pointer and allow the pilot to select any VOR course. The course pointer turns with the compass card and will be aligned with the lubber line when the helicopter heading is the same as the selected course.
Range Indicator	Digital distance display in kilometers (KM) to destination set on doppler FLY-TO-DEST.
HDG Knob	Heading select (HDG) knob operates in conjunction with the heading bug. It allows the pilot to select any one heading. With CMD selected on the HSI MODE SELECT panel, the afcs will turn the helicopter to and maintain the selected heading.
HDG Flag	The HDG flag is in view when the signal from the gyro magnetic compass is unreliable or power to the indicator is lost.
To-From Arrow	To-from arrow indicates that the helicopter is flying to or away from a selected VOR.
NAV Flag	The NAV flag turns with the compass card. The flag will retract from view when a reliable VOR doppler or FM homing signal is being applied to the instrument.
Aircraft Symbol	Corresponds to longitudinal axis of the helicopter; shows helicopter position and heading relative to the selected course.
Glide Slope Pointer	Displays glide slope position relative to the helicopter or FM homing signal strength. When pointer is above center, helicopter is below glide slope, conversely when pointer is below center, helicopter is above glide slope. Increasing homing signal strength is shown by pointer rising. Decreasing signal strength is shown by pointer falling.
Glide Slope (GS) Warning Flag	Indicates loss of or an unreliable glideslope or FM homing signal.

3-58. Horizontal Situation Indicator Mode Select Panel. (See fig. 3-14.)

The horizontal situation indicator mode select panel is on each pilots instrument panel below the horizontal situation indicator. The panel marked HSI MODE SELECT allows the pilot to select the navigation mode to be displayed on the hsi, command afcs heading select feature, and visually indicates marker beacon passage. The panel is divided into three sections marked CRS, BRG, and MKR BCN.

a. The CRS (course) section consists of four pushbutton selector switches marked VOR SEL, DOP SEL, FM SEL, and CMD SEL. Pressing VOR SEL, DOP SEL, or FM SEL causes the output of the selected navigation set to be electrically connected to the course deviation indicator on


2
18
19
3
4
1
17
177.7
RANGE
040
COURSE
5
16
15
14
6
7
8
13
9
12
10
11
N
33
30
24
21
S
15
12
E
6
NAV
HDG
GS
HDG
CRS
HSI MODE SELECT
CRS
BRG
VOR SEL
DOP SEL
FM SEL
CMD SEL
VOR ADF
O
M
I
MKR BCN

1. Range indicator (Km)
2. Compass card
3. Course pointer
4. Course indicator
5. No. 2 bearing pointer
6. Glide slope deviation marks
7. Glide slope deviation pointer
8. Glide slope failure flag
9. Course select knob
10. No. 1 bearing pointer
11. HSI mode select panel
12. Heading select knob
13. Course deviation indicator
14. To - from arrow
15. Heading failure flag
16. Course deviation marks
17. Navigation failure warning flag
18. Heading Bug
19. Lubber Line

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Figure 3-14. Horizontal Situation Indicator and Mode Select Panel

the corresponding hsi and lights SEL legend in the switch. These switches are electrically interlocked so only one set may be selected at a time. Selecting another navigational modes, automatically disengages the mode in use, turns out the SEL legend of the mode in use, engages the selected mode, and lights the SEL legend of the selected mode. Each pilot may independently select different navigational modes for display on his hsi.

b. Pressing CMD SEL engages the AFCS heading select feature, causes the helicopter to turn to and maintain heading to which the hsi heading bug is set, and illuminates the SEL legend on the switch. Due to electrical interlocks between the two hsi control panel, both CMD SEL switches cannot be engaged at the same time. The engaged switch is indicated by the lit SEL legend. If the opposite CMD SEL switch is pressed when operating with heading select, the HDG on the AFCS panel will release and heading select will be disengaged.

c. Pressing VOR/ADF pushbutton on the BRG side selects the navigational aid, the bearing of which will be indicated by the hsi No. 2 pointer. The switch is divided into two segments marked VOR and ADF. If the VOR segment is lit, the No. 2 pointer will indicate the bearing to a VOR station to which the VHF navigation set is tuned. Control of the course deviation indicator in the VOR mode relative to bearing and course deviation to or from a VOR is assigned to the pilot who has CMD SEL engaged. If the pilot who does not have CMD SEL engaged makes an adjustment on his CRS knob, it will have no effect on the CDI relative to the course. Pressing the switch will cause the VOR segment to go out, the No. 2 pointer to indicate the bearing to the station to which the ADF set is tuned, and the ADF segment to light. The opposite action occurs if the ADF segment is lit and the switch is pressed.

d. A MKR BCN light will come on during marker beacon passage. The light marked O comes on when passing thru an outer marker beam. The light marked M comes on when passing thru a middle marker and finally the light marked I comes on when passing thru an inner marker. As each light comes on, a distinctive tone identifying the beacon will be heard over the interphone. Refer to table 3-2 for marker beacon tones and indications. The lights have a press-to-test feature; pressing any one of the three lamps will cause all MKR BCN lamps to light plus the CRS and BRG mode select pushbuttons on both pilots HSI mode select panels.

3-58.1 Omega Navigation System (AN/ARN-148).

The AN ARN-148 is a global navigation system providing the crew with actual position, distance, bearing and receiver signal strength from (an) Omega Station(s). The system is comprised of: a Control Display Unit (CDU), a Navigation Processing Unit (NPU), an Airspeed Processing Unit (APU), and a Antenna Coupler Unit (ACU). The APU, takes information from the aircraft pitot system for airspeed calculations. Bearing is accessed from the magnetic compass. A microswitch is installed on the Oleo strut to lockout the system when the aircraft is on the ground. The system also features the capability of storing up to six (6) pages of flight plans for easy reference.

3-58.2 Navigation Principles (AN/ARN-148).

The Omega system uses a global network of Omega transmitting stations to provide dead reckoning coordinates to position the aircraft relative to one or more transmitting stations. The receiver utilizes four (4) basic frequencies:
10.2 KHz, 11.05 KHz, 11.33 KHz, and 13.6 KHz.
Worldwide stations include:

Norway	12.1 KHz	La Reunion	12.3 KHz
Liberia	12.0 KHz	Argentina	12.9 KHz
Hawaii	11.8 KHz	Australia	13.0 KHz
N. Dakota	13.1 KHz	Japan	12.8 KHz

Each Omega station transmits its frequency sequence during a ten-second transmission period. During the interval between RF bursts, the transmitter's frequency is changed to the next sequential RF burst frequency. The staggered pattern of frequency burst with the ten-second transmission period issued by the on-board receiver/computer to identify each Omega station.

These inputs are filtered by the NPU's 40 tracking filters. One filter is assigned to each of the four Omega frequencies, transmitted by each of the eight stations. The inputs consist of received signals and computed variances. This data is combined with velocity and heading information derived externally. External variables are critical to positional change estimates and total system accuracy.

3-58.3 AN/ARN-148 Control Display Unit.

The Control Display Unit (CDU) is mounted in the center console (Figure 2-6) and (Figure 3-14.1). The CDU functions as the primary source of input and output of navigation information with the operator. This data defines aircraft position and navigational guidance according to a selected path across the ground.

The CDU has a dual function. The display function is handled by a two inch by three inch color cathode ray tube (CRT). The CRT displays information in seven (7) different colors which uniquely communicates different information in different colors to the operator. The second function of the CDU allows the operator to input data into the system to define aircraft position along the desired navigational path. The data is entered through a key board consisting of thirty-three (33) keys. Two of the keys are used to select the display brightness and one key is used to turn the system on and off. The remaining thirty keys are used for alpha-numeric data input.

The alphabet is uniquely laid out so that there are no multi key stroke requirements for alpha information entry. The CLR key clears the data entry field, the ENT key enter data after it has been selected. The ALP key allows for mode switching between alpha and numeric data in fields where both need to be entered.

3-58.4 AN/ARN-148 CDU Controls.

Control/ Indicator	Function
BRT/DIM	Controls intensity of display.
ON/OFF	Applies or remover power.
CLR	Calls up cursor for data modification or cancels an operation.
ALP	During data entry alters key board from numeric to alpha mode and back to numeric mode.
ENT	Enters selected data into NPU memory.
NAV	Provides access to four pages of display relative to aircraft position and track leg data. Selected data pertinent to aircraft position and track leg data may be altered through these pages.
FPL	Provides display, assembly, selection, entry and modifications of flight plan.
LEG	Provides for display and selection of from and to waypoints. Provides for display and selection of track change mode.
-D→	Provides a means of flying from present position direct to a defined waypoint.
↓↑	Provides a means of displaying additional data when more than 8 lines of data are available.
HLD	Provides a means of manually updating position either by entering lat/long coordinates or by reference to point which has already been defined to the ONS.
EDT ←	During data entry mode provides a back scape function. During non-data entry mode provides the capability to change display mode of angola-data, i.e., magnetic, true, grid, heading, bearing, DTK.
*	Identifies and permits entry of waypoints as a range and bearing from a previously entered waypoint.
DAT	Provides six pages for the selection, display, and entry of data related to flight planning and Omega/VLF status.
MSG	Provides a display of system malfunctions and operator actions required. Displays condition of ONS data base and allows selection of various test modes to ensure correct system operation.
E	The "E" or "5" key provides a means of calling the erase function when the cursor is displayed at the top of the Flight Plan page.
I	The "I" or "9" key provides a means of inverting the Flight Plan when the cursor is displayed at the top of the Flight Plan page.
S	The "S" or ↓ key provides a means of selecting the Flight Plan for use when the cursor is displayed at the top of the Flight Plan page.
O	The "O" (alpha) key provides a means for the operator deselection of an Omega or VLF station when the cursor is positioned on the same line as the station to be deselected.

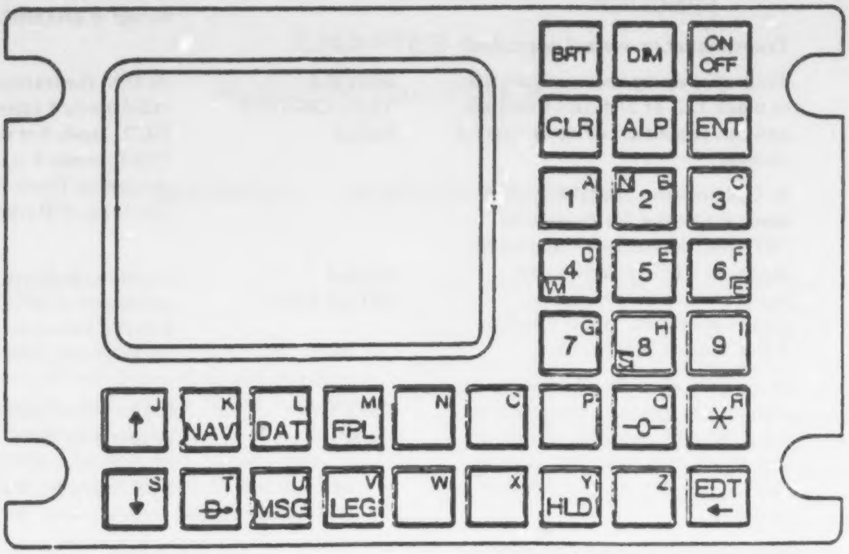
BRT
DIM
ON OFF
CLR
ALP
ENT
1 A
N 2 B
3 C
4 D
W
5 E
6 F
E
7 G
8 H
S
9 I
↑ J
NAV K
DAT L
FPL M
N
O
P
Q
R
↓ S
T
MSG U
LEG V
W
X
HLD Y
Z
EDT ←

Figure 3-14.1 Omega Control Display Unit (CDU) AN/ARN-148

SECTION IV TRANSPONDERS

3-59. Transponder System (AN/APX-100).

The transponder system provides automatic radar identification of the helicopter. The system receives, decodes, and replies to interrogations on modes 1, 2, 3/A, 4, TEST and C from all suitably equipped challenging aircraft or ground facilities. The receiver section operates on a frequency of 1030 mHz and the transmitter section operates on a frequency of 1,090 mHz. Because these frequencies are in the uhf band, the operational range is limited to line-of-sight. The system is powered by the No. 2 dc bus thru the IFF circuit breaker on No. 2 power distribution panel.

3-60. Receiver-Transmitter-Control Panel.

The integral receiver-transmitter-control panel is on the console. It receives coded interrogating pulses in modes 1, 2, 3/A, 4 and C and tests them for validity. If the signals conform to the preset mode and code, a coded reply is transmitted. Additional preset codes for emergency use are available when selected at the transponder control panel. These emergency codes are transmitted on modes 1, 2, 3/A and 4 regardless of codes selected. Transponder functions are continuously monitored by built-in-test circuits. Each mode also has a self-test feature which can be selected by the pilot to verify operation. The receiver-transmitter must be removed from the console to replace the fuse.

3-61. Transponder Control.

The transponder control (fig. 3-15) is on the console. It is part of the integral receiver-transmitter-control. It provides the control switches for application of power, setting of the modes and codes, modes of operation, identification of position, and emergency functions of the set.

3-62. Deleted.

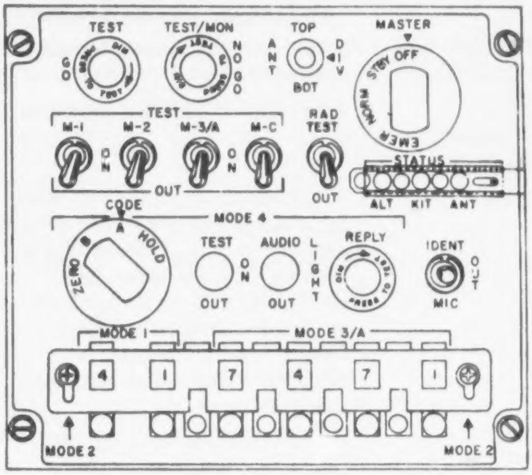
TEST
GO
TEST/MON
NO GO
TOP
ANT
DIV
BOT
MASTER
STBY
OFF
NORM
EMER
TEST
M-1
M-2
M-3/A
M-C
ON
OUT
RAD TEST
OUT
STATUS
ALT
KIT
ANT
CODE
ZERO
B
A
HOLD
MODE 4
TEST
ON
OUT
AUDIO
LIGHT
OUT
REPLY
IDENT
OUT
MIC
MODE 1
MODE 3/A
4
1
7
4
7
1
MODE 2
MODE 2
11975

Figure 3-15. AN/APX-100 Control Panel

3-63. Controls and Function, Transponder Control (RT-1285/APX-100). (See fig. 3-15.)

CONTROL/ INDICATOR	FUNCTION
MASTER Control Switch :	
OFF	Removes power from transponder set and computer.
STBY	Power is applied to transponder receiver and computer; transmitter inoperative. Set ready for operation after 2 minute warmup in STBY.

CONTROL/ INDICATOR	FUNCTION
NORM	Transponder in normal operation.
EMER	Transmits emergency reply signals to mode 1, 2, or 3/A and 4 interrogations, regardless of mode control settings.
M-1, M-2, M-3/A Switches	At ON position, the applicable mode is selected for operation. OUT position turns off applicable mode. At TEST position, that particular mode is tested for proper operation. If test is valid, TEST lamp will come on.
M-C	In mode C, altitude information is provided to ground controllers by the AAU-32A encoding altimeter. Switch position functions are the same as for M-1, M-2, and M-3A switches.
MODE 1 Selector Switches	Selects and indicates a two digit 32 code reply number.
MODE 2 Selector Switches	Selects and indicates a 4 digit 4096 code reply number. (Switches are preset and covered by a guard. Only the reply code can be seen.)
MODE 3/A Selector Switches	Selects and indicates a 4 digit 4096 code reply number.
MODE 4 CODE Control Switch	Selects type of MODE 4 operation.
HOLD	This function is enabled only when the right aft landing gear strut is compressed. It holds the MODE 4 code which would otherwise be cleared when the set is turned off or electrical power is removed. Switch is spring-loaded to A. HOLD function is reset when the transponder is turned on.
A	Enables transponder to reply to code A interrogations.
B	Enables transponder to reply to code B interrogations.
ZERO	Clears (zeroizes) mode 4 code settings in transponder computer.
MODE 4 AUDIO LIGHT OUT Switch	At AUDIO, the REPLY indicator light will come on when the transponder replies to valid mode 4 interrogations. A pulse tone will be heard in the headset when a code A interrogation is received but the CODE control switch is in B position and vice versa. At LIGHT, only the light will come on when the transponder replies to mode 4 interrogations. At OUT, the audio and REPLY light monitoring is disabled.
MODE 4 TEST-ON-OUT Switch	At ON, the transponder replies to valid mode 4 interrogations. At OUT, mode 4 is disabled. At TEST, mode 4 is tested for proper operation. If test is valid, TEST GO lamp will come on.
Mode 4 REPLY Light	Lights to indicate valid mode 4 replies when MODE 4 AUDIO LIGHT switch is set to either AUDIO or LIGHT.
TEST GO Light	Lights when transponder responds properly to TEST position of M-1, M-2, M-3/A, M-C, or MODE 4 TEST-ON-OUT switches
TEST/MON NO GO Light	The light is on when any of the following occurs: a. MASTER switch is on STBY. b. Transponder does not respond to interrogation. c. Transponder does not respond to TEST position of mode switches. d. Transponder malfunctions.
RAD TEST Switch	At RAD TEST, the transponder replies to interrogations from external test equipment. At OUT, the RAD TEST feature is inoperative.
IDENT-MIC Switch	At IDENT, the set will transmit a coded identification pulse for about 20 seconds to all interrogating stations on modes 1, 2, and 3/A to identify the helicopters position. OUT position turns off the identification pulse. MIC feature is not used in this installation.
STATUS Indicators	The indicator lights are part of built-in test equipment. A lit ALT indicator indicates trouble in the encoding altimeter. A lit KIT indicator indicates trouble in the computer or the computer is not installed. A lit ANT indicator indicates antenna trouble.
ANT Switch	Three-position antenna diversity switch labeled TOP, DIV, and BOT. Normal position is DIV. When jamming is heavy, TOP or BOT antenna may be selected.

CHAPTER 4
MISSION EQUIPMENT

SECTION I MISSION AVIONICS

4-1. Radar Signal Detecting Set (AN/APR-39).

The radar signal detecting set provides visual and aural indication of the presence of and bearing to active radar transmitters. The set detects those radar signals usually associated with hostile fire control radar in the E, F, G, H, I, and J frequency bands. The set also detects missile guidance radar signals in the low C and D bands. The bearing to the transmitter and relative signal strength is displayed on a cathode ray tube indicator on the center instrument panel. When low-band missile guidance signals are time correlated with high band radar tracking signals (indicating an activated missile radar complex) a MA (Missile Alert) lamp will flash on the indicator and a warning tone will be heard on the interphone. The warning tone is a direct input to the interphone system and interphone control panel switch settings are not necessary. The system consists of the indicator on the center instrument panel (fig. 4-2), the detecting set control panel on the console (fig. 4-1), four high band spiral antennas, one low band blade antenna, two radar receivers and a signal comparator on the avionics shelf. One of the spiral antennas is mounted on each side of the nose enclosure. One is mounted on each side of the aft pylon. The blade antenna is mounted on the bottom of the fuselage aft of sta 95. The four spiral antennas are tuned to high band signals. The blade antenna is tuned to low band signals. One radar receiver, connected to the two forward spiral antennas, its mounted inside the nose enclosure. The other radar receiver, connected to the two aft spiral antennas, is mounted in the aft pylon, forward of the antennas at sta 604. The radar receivers, detect, and amplify the signals picked up by the two associated spiral antennas. The receivers then apply a pulse output signal to the comparator on the avionics shelf for processing. The comparator performs the logic necessary to determine if the necessary criteria have been met to indicate that a valid signal is present either as a threat or near-threat. The comparator applies those valid signals to the indicator for display. The indicator display mode is controlled by the DSCRM switch on the detecting set control panel. The indicator on the center instrument panel consists of a cathode ray tube (crt), a red MA (missile alert lamp), a brilliance control, and a day/night filter. A graticule covering the face of the crt, is divided into four equal sectors. The graticule is further divided by four concentric circles. The concentric circles are reference marks only and are not range markings. Also, strobe length is not indicative of range to the radar transmitter. Strobe length indicates received signal strength only. Power is from the 28-volt No. 1 dc bus thru RAD WARN circuit breaker on the No. 1 power distribution panel.

4-2. Controls and Function, Radar Signal Detecting Control. (See fig. 4-1.)

CONTROLS/ INDICATOR	FUNCTION
Power Switch	Two position switch. At ON, power is applied to set. Set is operational after a 1-minute warmup.
SELF TEST Switch	Switch is spring-loaded to off. When pressed, the self test function is enabled.
AUDIO	When turned clockwise, the audio output of the set is increased.
DSCRM (Discriminator)	Two position switch. At OFF, all high-band signals of amplitude greater than predetermined threshold level are displayed. At ON, only those signals which conform to predetermined threat-associated criteria are displayed.

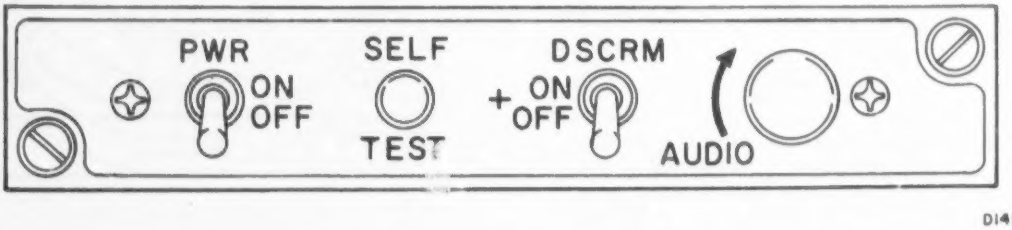

Figure 4-1. Radar Signal Detecting Set Control

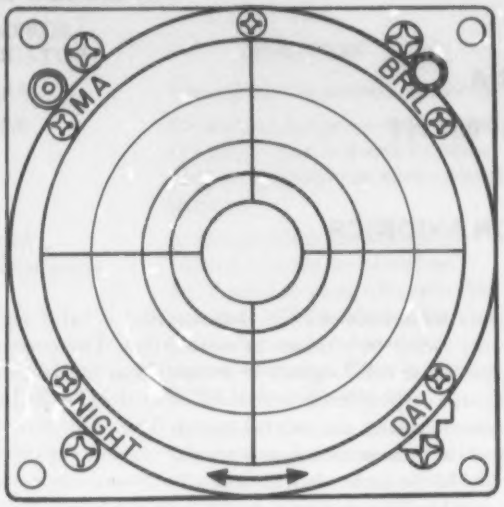

Figure 4-2. Radar Signal Detecting Set Indicator

4-3. Controls and Function, Radar Signal Detecting Set Indicator.

CONTROLS/ INDICATOR	FUNCTION
Radial Strobe	Displayed on indicator. Shows bearing to each radar transmitter.
Red MA Indicator	Flashes on and off with alarm audio to indicate time correlation between missile guidance and associated tracking radars.
BRIL Control	Varies the brilliance of the indicator display.
Filter Control	Marked DAY and NIGHT. Varies the density of the strobe from bright green for day operation to red for night operation.

NOTE

The concentric circles are reference marks only and are not range markings. Also, strobe length is not indicative of range to the radar transmitter. Strobe length indicates received signal strength only.

4-4. Normal Operation — Radar Signal Detecting Set. This paragraph provides radar signal detecting set operating procedures.

CAUTION

To prevent damage to the set (when it is operating) be sure the helicopter is positioned so the detecting set antennas are at least 60 yards from active ground based radar antennas. Allow an extra margin for new, unusual, or high-powered radar transmitters.

a. Starting.

1. RAD WARN circuit breaker on No. 1 power distribution panel — check in.
2. Battery switch — ON.
3. PWR switch — ON. Allow 1 minute for warmup.

b. Self-test check.

1. DSCRM switch — OFF.
2. SELF-TEST switch — Press.

Check for the following:

(a) Forward and aft strobes appear on the indicator and they extend from the center of the indicator to about the second concentric ring on the graticule.

(b) Check for 2500-Hz tone in the interphone.

(c) Check that an alarm audio is heard and red MA lamp starts flashing within 6 seconds.

(d) Release SELF-TEST switch. check that all indications stop.

3. DSCRM switch — ON.
4. SELF-TEST switch — Press.

Check for the following:

(a) In about 4 seconds, a forward or aft strobe apears (either may appear first) and a 1200-Hz pulse tone is present in the interphone.

(b) In about 6 seconds, the other strobe appears and the pulse frequency doubles.

(c) Several seconds later the alarm audio is heard and the MA lamp starts flashing.

5. SELF-TEST switch — release.
6. PWR switch — as desired.

c. Operating modes.

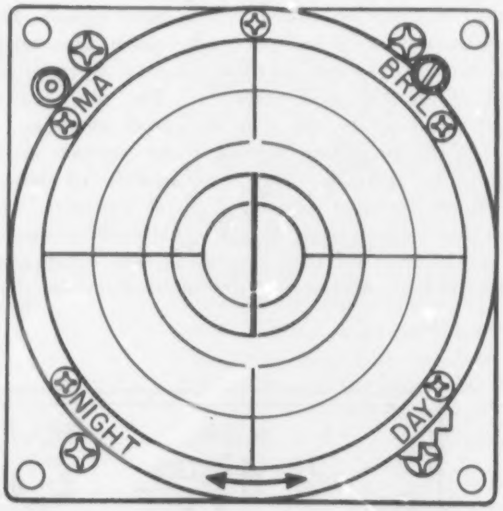

Figure 4-3. Radar Signal Detecting Set Display (Self-Test Mode)

1. Discriminator off mode. (See fig. 4-4.) The set will display all wide-band radar signals which have an amplitude greater than a specific threshold. Audio represents the repetition frequency and amplitude of the threat signals. Presence of possible threat signals is indicated by a flashing MA lamp and alarm audio.

2. Discriminator on mode. (See fig. 4-5.) In discriminator on mode, no high band signals will be displayed on the indicator unless the following threat criteria has been established; the threshold signal level is exceeded, maximum pulse width has not been exceeded, minimum pulse repetition frequency has been exceeded, and pulse train persistance has been established. When a threat has been established, the associated strobe on the indicator and the MA lamp will flash, and a unique audio tone will be heard in the headset. It is possible for non-threat signals to be displayed in the same sector on the indicator as threat signals. The set is blanked when the transponder replies to interrogations from a challenging facility. The set receives power from the 28-volt No. 1 dc bus thru the 5-amp RAD WARN circuit breaker on the No. 1 power distribution panel.

4-5. Countermeasures Set (AN/ALQ-156)

The Countermeasures Set (AN/ALQ-156) detects the approach of anti-aircraft missiles, and signals the M-130 Flare Dispenser to launch flares to decoy the missiles from the helicopter. The set consists of a control unit on the console, a receiver-transmitter in the electronics compartment, two antennas on the bottom of the fuselage, and two caution lights on the master caution panel. The set alternately applies pulsed signals to the two antennas which radiate the signals about the helicopter. A missile approach is detected by the frequency shift of the transmitted signals echo returned from the missile. Any echo is received during the interval following each pulsed transmission. Built-in-test-equipment monitors system operation. If a malfunction is detected, the system is disabled and the CM INOP caution light on the master caution panel will come on. Also, if enemy jamming or interference from other countermeasure sets is detected, the set will automatically shift to a clear channel. The set receives ac electrical power from the No. 2 three-phase bus thru 3-phase MSL DET SYS circuit breaker on the No. 2 pdp. The set receives dc power from the No. 2 dc bus thru the MSL DET SYS circuit breaker also on the No. 2 pdp.

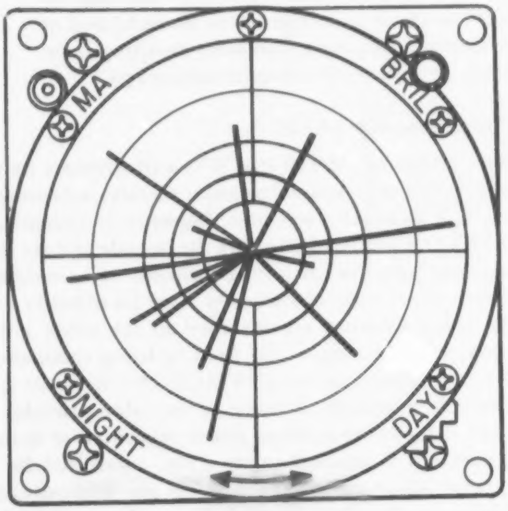

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Figure 4-4. Radar Detecting Set Indicator Display (Discriminator Off)

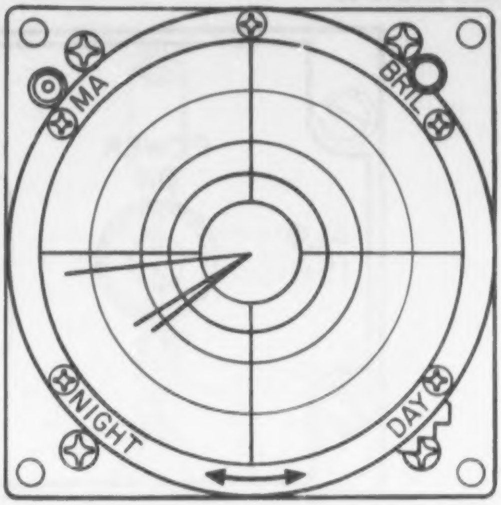

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Figure 4-5. Typical Radar Signal Detector Display (Discriminator On)

4-6. Controls and Indicators, Missile Detector Set (AN/ALQ-156). (See fig. 4-6.)

CONTROL/ INDICATOR	FUNCTION
POWER OFF/ON	At ON, power is applied to set. The switch is locked at ON. Signals radiate after the normal warmup period is completed.
STBY Indicator Light on STATUS Switch	Lights when switch is depressed and system is in standby operation.
Amber Warmup Caution Light on STATUS Switch	Lights when power is applied to set and remains on until operating temperatures are reached.
FLARE TEST Switch	Simulates launch command signal to flare dispenser.
CM INOP Caution Light (on caution panel)	When lit indicates the set has failed and the helicopter is without countermeasures protection.
CM JAM Caution Light (on caution panel)	Lights when system detects mutual interference from nearby countermeasures sets or enemy jamming.

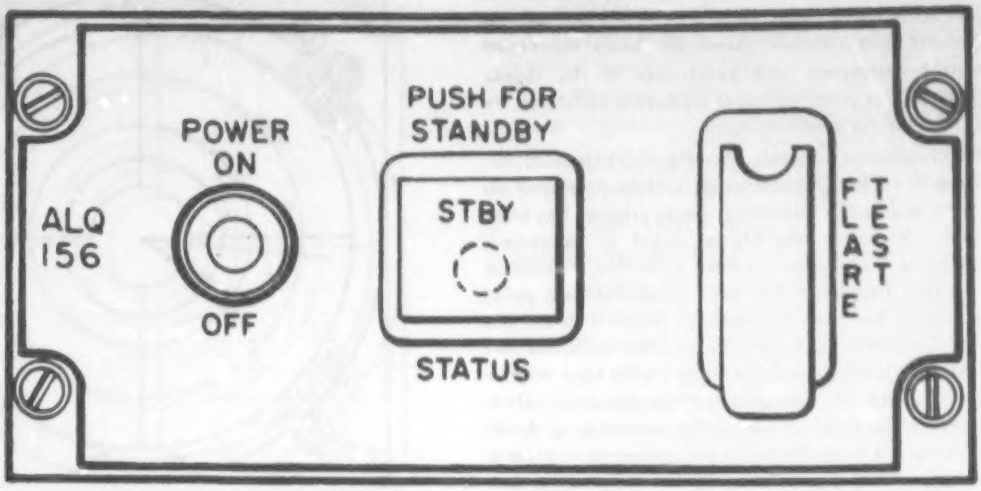

Figure 4-6. Countermeasures Set Control Panel (AN/ALQ-156)

4-7. Normal Operation; Countermeasure Set.

WARNING

An accidental flare launch can occur when the Flare Dispenser System is armed (control switch at ARM) and the Countermeasures Set is operating (CM caution and indicating lights off). A flare launch will also occur if the FLARE TEST switch on the countermeasures control panel is operated. Arm these systems only in cases where a launched flare will not cause injury or property damage. Also, when the set is operating, the antennas radiate radio-frequency energy. This energy may cause burns to personnel near the antennas. Be sure ground personnel are at least 6 feet from the antennas when the control switch is at ON. See fig. 3-3 for antenna locations.

a. Starting.

1. MSL DET SYS circuit breakers on No. 2 pdp — Check in.

WARNING

The system requires a 10-minute warmup prior to operation. To ensure automatic system operation when required, be sure the set is operational and all caution and indicator lights are out prior to entering hostile areas.

2. POWER control switch — ON.

3. Warmup light — ON, allow 10-minutes for warmup. At the end of the warmup period, the warmup light will be cut off.

b. ECM operation.

1. STATUS switch — Push for standby operation or release to commence automatic protection.

2. CM JAM caution light — Check OUT.

3. CM INOP caution light — Check OUT. If caution light is on, the set has malfunctioned and the helicopter is without countermeasures protection.

4. POWER switch — OFF when countermeasures protection is no longer required.

WARNING

If the countermeasures set has been off for less than 5 minutes and further operation is required, the warmup indicator light may go out immediately (or within some time interval less than the normal 10 minute warmup period) after the power switch is set to on. If this occurs, it is mandatory that the system be operated in STBY for at least 1 minute. Failure to observe this requirement can result in a false alarm (launch) and or transmitting frequency instability resulting in interference with other countermeasures sets.

4-8. Flare Dispenser M-130.

The Flare Dispenser M-130 (fig. 4-7) will dispense up to 30 decoy flares as a countermeasure to infrared-seeking missiles. The externally mounted dispenser is controlled by a DISP CONT control panel on the console and six firing switches. Two cockpit firing switches are provided, one on each pilot's control stick grip. Four hand-held crew member firing switches are installed in the cabin area. Flares can also be automatically fired by firing commands from the countermeasure set (AN/ALQ-156) if the set detects a missile approach. A timer in the cabin provides a 2.5 second delay between firing pulses regardless of firing switch position. A ground safety relay, controlled by a landing gear squat switch and a safety pin manually installed into the dispenser, prevents firing flares when the helicopter is on the ground. The system is powered by 28-volts dc from the No. 1 dc bus thru the 7.5 ampere CHAFF circuit breaker on the No. 1 pdp.

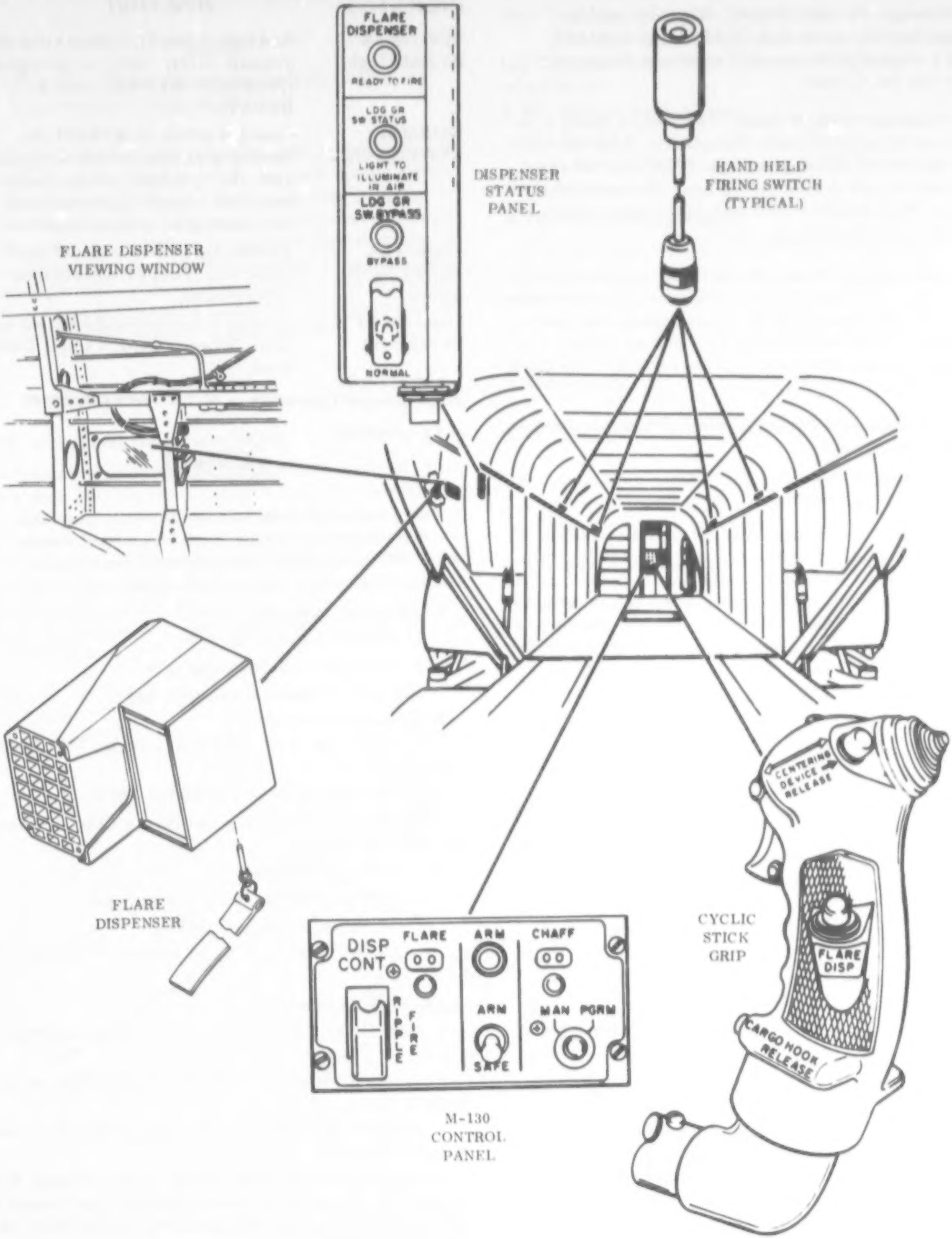
FLARE DISPENSER
READY TO FIRE
LDG GR SW STATUS
LIGHT TO ILLUMINATE IN AIR
LDG GR SW BYPASS
BYPASS
NORMAL
DISPENSER STATUS PANEL
HAND HELD FIRING SWITCH (TYPICAL)
FLARE DISPENSER VIEWING WINDOW
FLARE DISPENSER
DISP CONT
FLARE
ARM
CHAFF
RIPPLE FIRE
ARM
SAFE
MAN PGRM
M-130 CONTROL PANEL
CYCLIC STICK GRIP
CENTERING DEVICE RELEASE
FLARE DISP
CARGO HOOK RELEASE
0145-309-10

Figure 4-7. Flare Dispenser System

NOTE

Although the control panel, dispenser, and circuit breaker are marked CHAFF or have CHAFF (C) selector positions, chaff cannot be dispensed in this installation.

4-9. Dispenser Control Panel. The control panel is installed on the pilot's console. The panel contains the ARM SAFE switch, ARM indicator light, RIPPLE FIRE switch, flare counter, and counter setting knob. The panel also includes a MAN-PGRM switch and chaff counter, which are not used in this installation.

4-10. Dispenser Status Panel. The dispenser status panel (fig. 4-7) provides an indication of safety relay operation and system arming. It also allows the landing gear safety switch to be bypassed for ground testing of the dispenser system. The panel is on the left side of the cabin at station 534.

4-11. Controls and Function, Flare Dispenser System (M-130) (See fig. 4-7.)

CONTROLS/ INDICATOR	FUNCTION
ARM/SAFE Switch	At SAFE, the system is not powered. At ARM, the system is powered, provided the safety pin is removed from the electronic module and the ground safety relay is energized. (Helicopter airborne or remote bypass switch on remote test panel is at BYPASS.)
ARM Indicator Light	Red PRESS-TO-TEST warning light indicates, when lit, that ARM/SAFE switch is at ARM, safety relay is closed, and safety pin is not installed in electronic module.
FLARE Counter	Two digit counter displays number of flares remaining in the dispenser. The number of flares loaded is set manually, using the knob directly below the counter.
RIPPLE FIRE Switch	Guarded two-position switch allows rapid emergency ejection of all remaining flares.
CHAFF Counter	Not used in this installation.
MAN/PGRM Switch	Light intensity controlled by caution panel DIM/BRT SW.
Dispenser Status Panel	(See fig. 4-7).
READY TO FIRE Light	Amber light comes on when system is armed and ready to fire. Light receives power through timer and will go out for 2.5 seconds after flare launch.
LDG GR SW STATUS Light	Green light comes on when ground safety relay is energized. The ground safety relay is energized when the helicopter is airborne or on the ground when the LDG GR SW BYPASS is at BYPASS.
LDG GR SW BYPASS Light	Red light, when lit, indicates that the ground safety relay is energized (NORMAL/BYPASS switch is at BYPASS).
NORMAL/ BYPASS Switch	Guarded switch. At BYPASS, the landing gear safety switch is bypassed and the ground safety relay is energized. Switch normally used to test system prior to installing flares.
Cyclic Stick FLARE DISP Switch	Pushbutton switch on side of each cyclic stick. Fires a flare each time when pressed.
Hand Held Firing Switches (4)	Located in forward and aft cabin sections. When pressed, a single flare is fired.

4-12. Normal Operation — M-130 Flare Dispenser.

4-13. Preflight.

WARNING

An inadvertent flare launch can occur when the Flare Dispenser System is armed (control switch at ARM) and the Countermeasures Set is operating (CM caution and indicating lights off).

a. Dispenser Assembly.

1. Selector switch — Set to F.
2. Safety pin — Remove and stow.
3. Flares — Note quantity installed.

b. Dispenser Status Panel.

1. LDG GR SW BYPASS switch — NORMAL. Cover down.
2. Indicator lights — PRESS TO TEST.

c. Cabin hand held firing switches — Check connected and secured in holder.

d. Cockpit control panel.

1. RIPPLE FIRE switch — Cover down.
2. ARM/SAFE switch — SAFE.
3. FLARE counter — Set to amount of flares in dispenser.

4-14. In-flight Operation.

a. After liftoff, LDG GR SW STATUS advisory light on remote test panel — Check lit.

b. ARM/SAFE switch — ARM. Check ARM warning light lit.

c. READY TO FIRE caution light on dispenser status panel — Check lit.

d. ECM set — ON. Allow 10 minutes for warmup. Refer to para 4-7. The ECM set will monitor the area around the helicopter for missiles and automatically fire flares when missiles are detected.

NOTE

The flare dispenser can be safely observed from the cabin through the filtered glass window on the left side of the helicopter above the ramp at sta 575.

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e. If the ECM set is inoperative, proceed as follows:

NOTE

The crewmember observing a missile launch is responsible for firing the flares.

1. Press the firing switch to fire a flare. Fire a total of three flares, at 3-second intervals, for each missile threat. The dispenser will fire one flare each time a button is pressed following the 2.5-second time-delay as indicated by the ready-to-fire lights. If the flare fails to ignite, a second flare will automatically fire within 75 milliseconds. If burning is still not detected, a third flare will be fired. If all three flares fail to ignite, automatic operation will stop until one of the fire switches is again pressed.

2. Announce over interphone that a missile launch was detected and flares have been fired.

3. If more than one launch is observed, continue firing flares at 3-second intervals until the helicopter is clear of the threat.

4-15. Before Landing Check.

a. ARM-SAFE switch — Set to SAFE.

b. Indicator lights — Check that READY TO FIRE and ARM lights are out.

4-16. After Landing Check.

a. Check that the LDG GR SW STATUS light goes out.

b. Install the ground safety pin in the dispenser electronic module.

c. Remove and stow the crew firing switches.

SECTION II ARMAMENT

4-17. Armament Subsystem (M24).

The armament subsystem M24 (fig. 4-8) is installed in the cabin door and the cabin escape hatch. The two flexible 7.62 mm machine guns (M60D) (fig. 4-9) are free pointing but limited in traverse, elevation, and depression by cam surfaces, stops on the pintles, and pintle posts of the left and right mount assemblies (fig. 4-9). Spent cartridges are collected by an ejection control bag (fig. 4-10) on the right side of the machine gun. An ammunition can (fig. 4-11) is on the left side.

4-18. Machine Gun.

The 7.62 machine gun (M60D) (fig. 4-9) is a link-belt-fed gas-operated air-cooled automatic weapon. It is mounted on the left and right side pintles.

4-19. Mount Assemblies.

The mount assemblies (fig. 4-12) are installed on mounting brackets fastened inside the helicopter and secured with mounting pins.

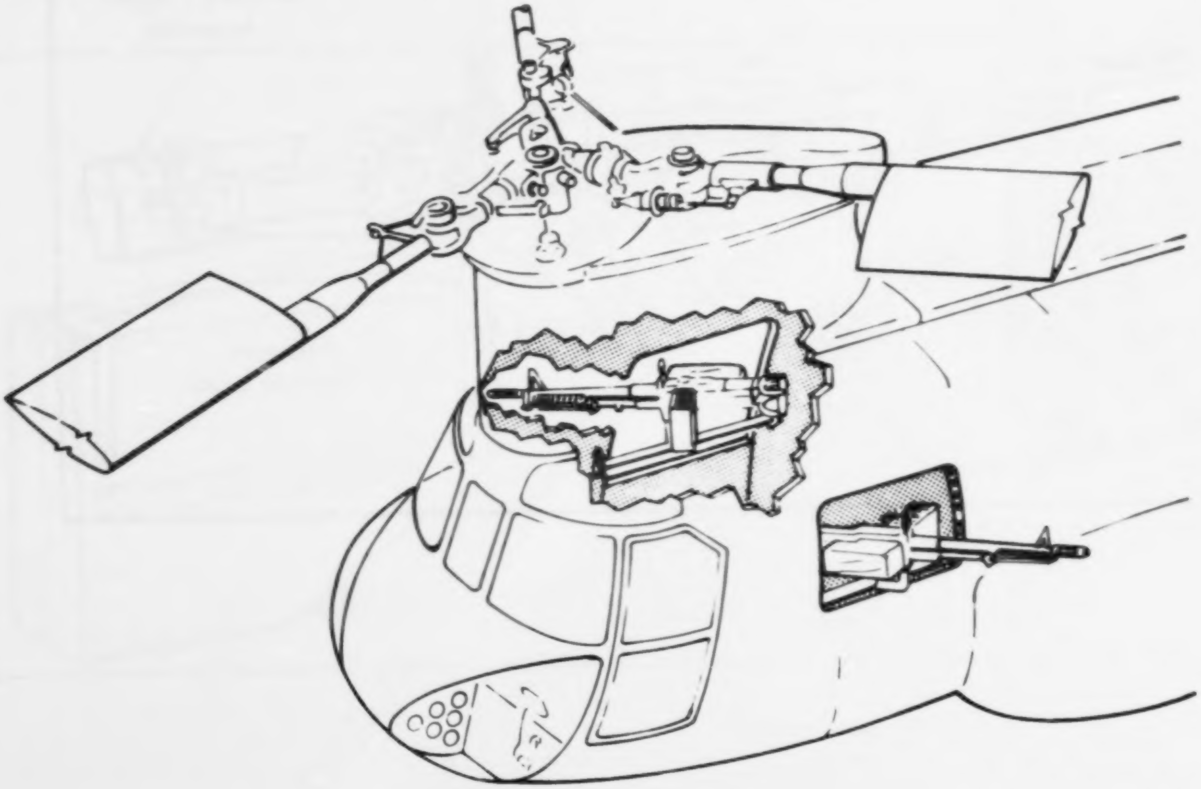


Figure 4-8. M24 Armament Subsystem

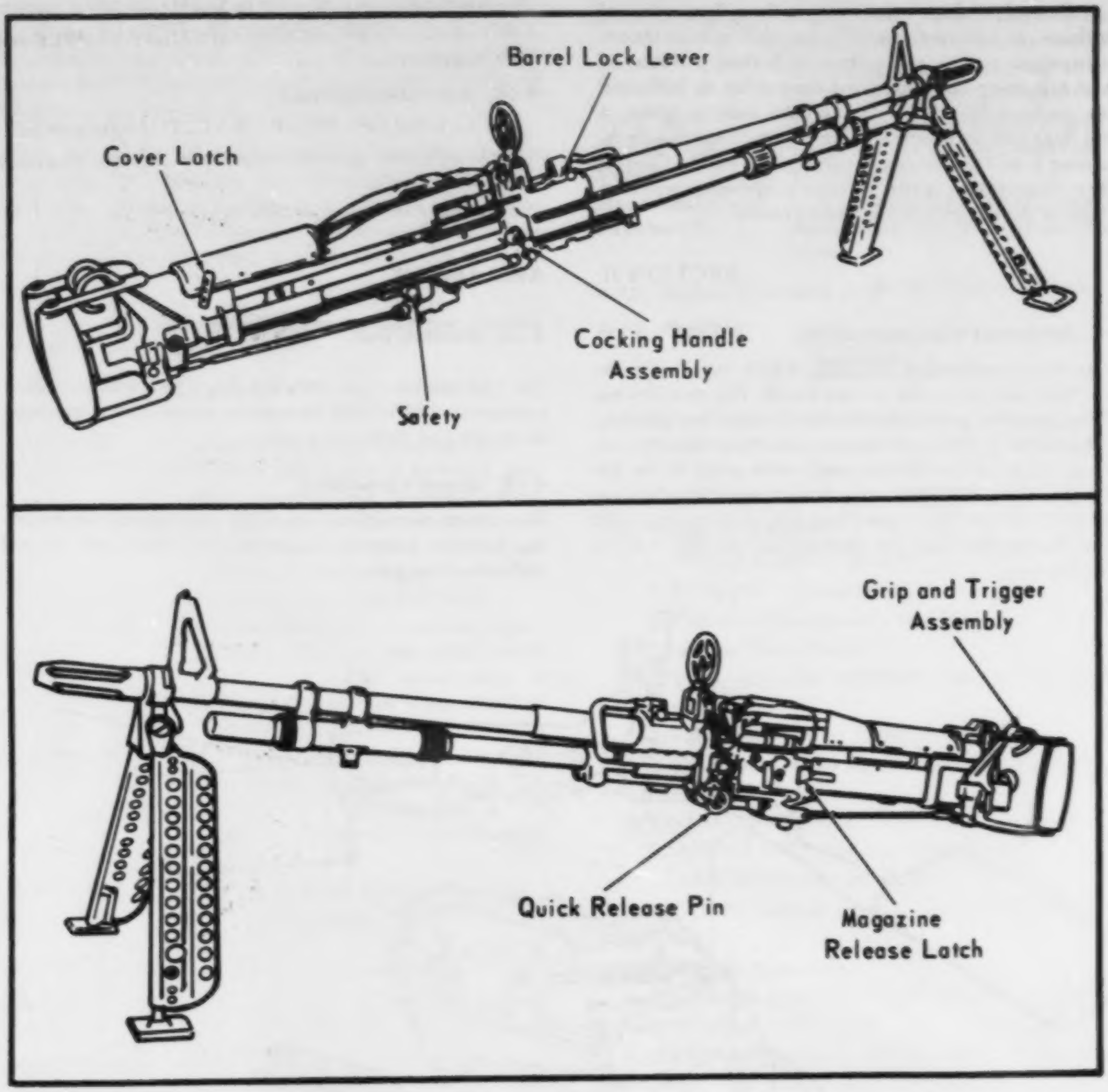

Barrel Lock Lever
Cover Latch
Cocking Handle Assembly
Safety
Grip and Trigger Assembly
Quick Release Pin
Magazine Release Latch

Figure 4-9. Machine Gun M60D

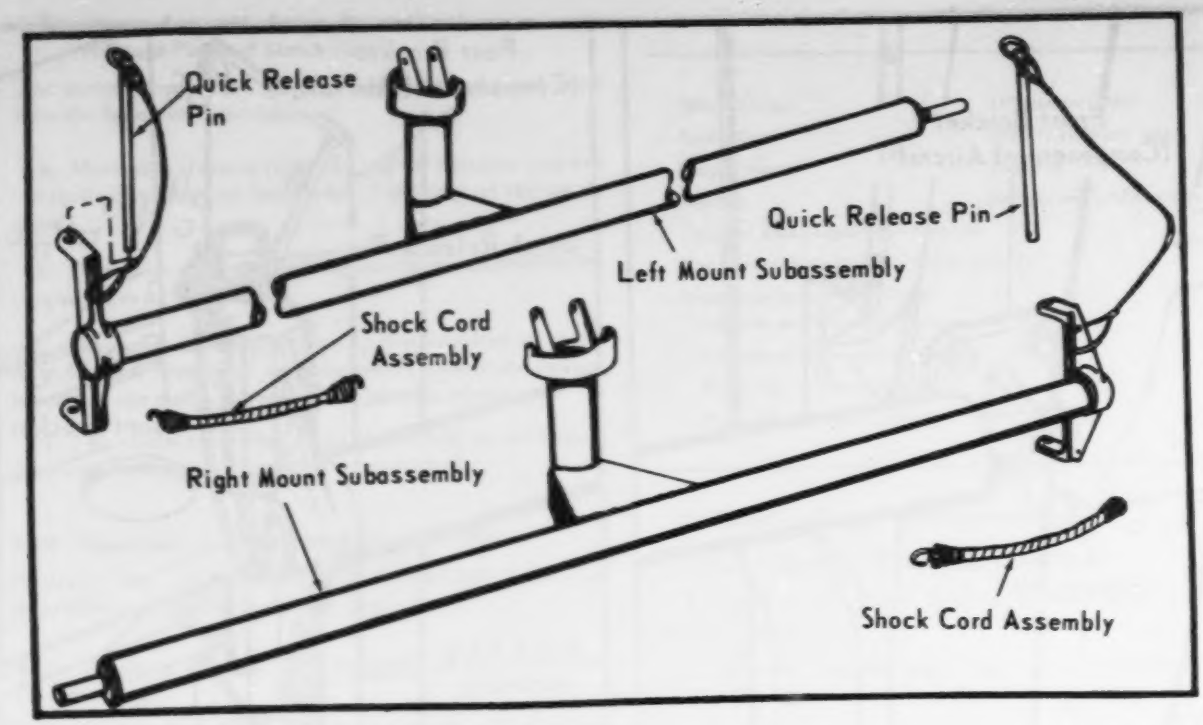

Quick Release Pin
Quick Release Pin
Left Mount Subassembly
Shock Cord Assembly
Right Mount Subassembly
Shock Cord Assembly

Figure 4-10. M24 Mount

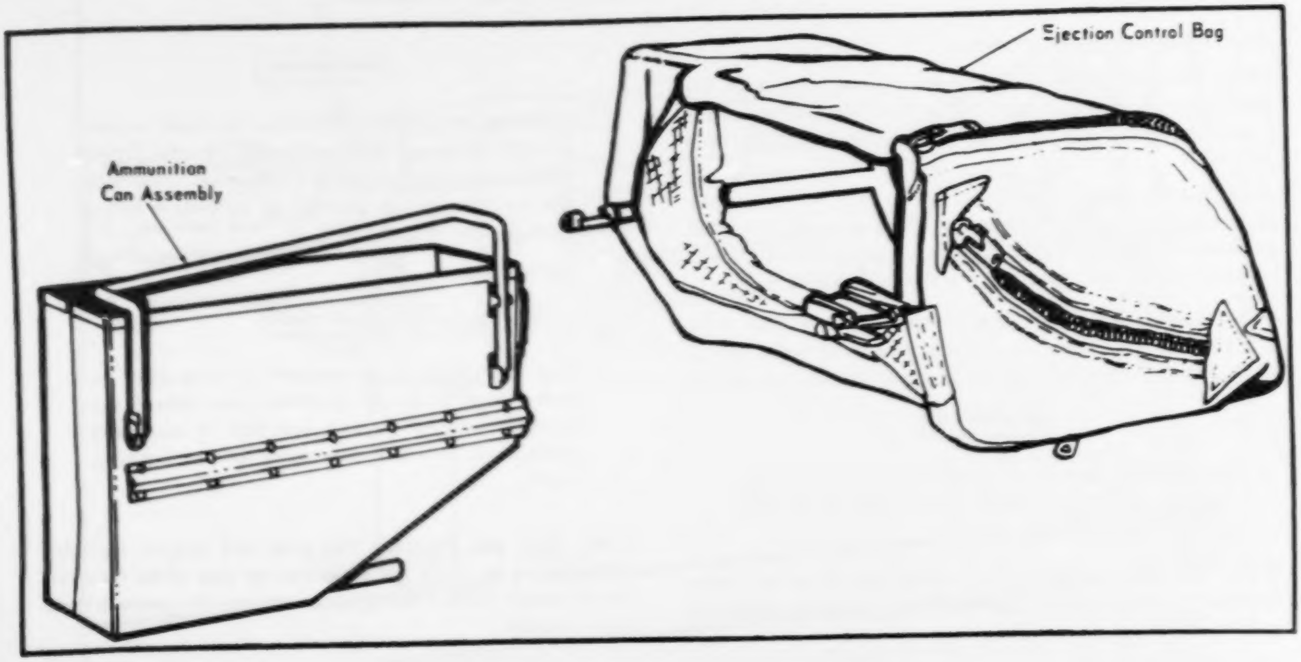

Ejection Control Bag
Ammunition Can Assembly

Figure 4-11. Ammunition Can and Ejection Control Bag

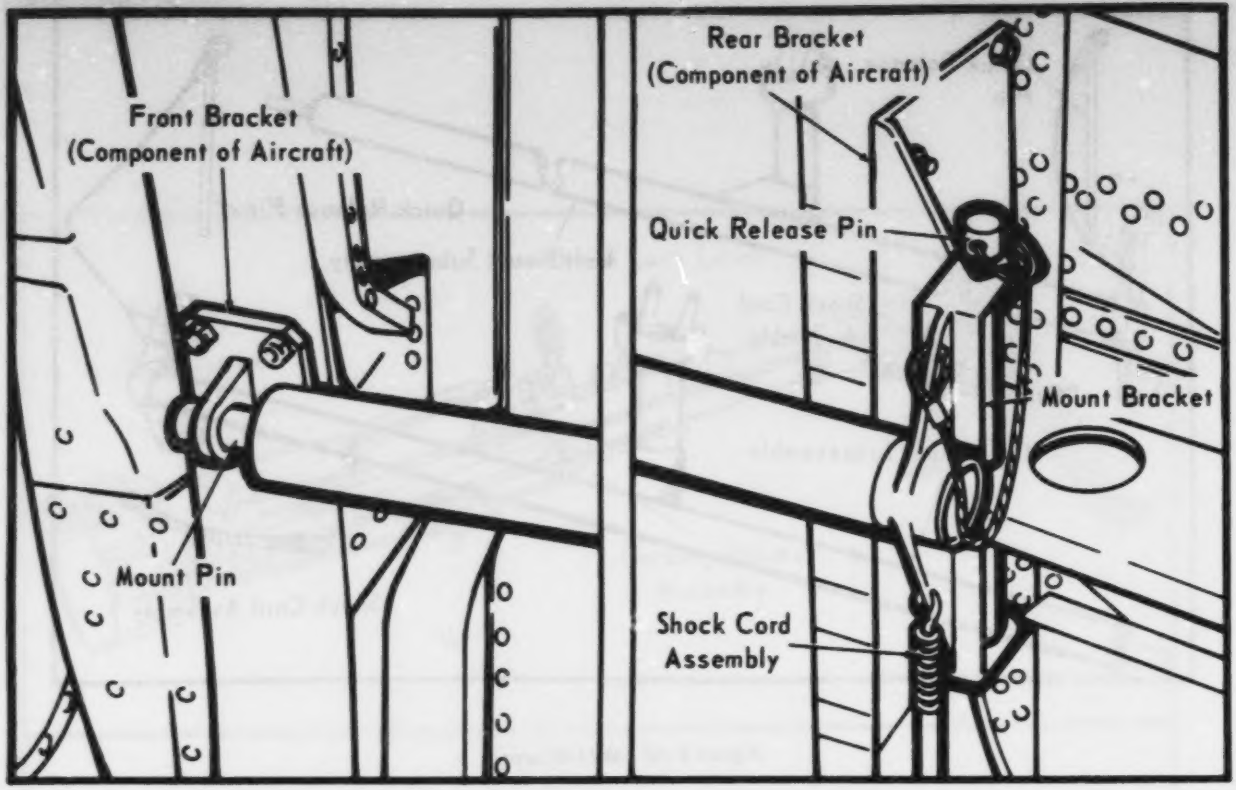


Figure 4-12. Right Machine Gun Mount — Installed

4-20. Machine Gun Controls.

These paragraphs locate and describe the controls for operating the machine gun M60D. For information on the basic 7.62 mm machine gun M60D, refer to TM 9-1005-224-10.

4-21. Cover Latch. The cover latch (fig. 4-9) is at the right rear side of the feed cover. When placed in vertical position, it secures the cover in closed position. When turned to horizontal position, it unlocks the cover.

4-22. Barrel Lock Lever. The barrel lock lever (fig. 4-9) at the right front side of the receiver is secured to the barrel locking shaft. It turns the shaft to lock or unlock the barrel.

WARNING

To prevent injury to personnel, the cocking handle must be returned to the forward or locked position before firing.

4-23. Cocking Handle. The cocking handle at the right front side of the receiver is used for manually charging the machine gun.

4-24. Safety. The safety, at the lower front section of the receiver, consists of a cylindrical pin with a sear clearance cut. The pin slides across the receiver to block the sear and prevent accidental firing. The ends of the pin are marked for pushing to safe (S) and firing (F) positions (fig. 4-9).

WARNING

Pressing the trigger to release the bolt accomplishes feeding and releasing of the firing mechanism. Unless firing is intended, make sure the machine gun is cleared of cartridges before pressing the trigger.

CAUTION

To prevent damage to the cartridge tray when no ammunition is in the machine gun, retard the forward force of the released bolt by manually restraining forward movement of the cocking handle.

4-25. Grip and Trigger. The grip and trigger includes the spade grips which are at the rear section of the receiver. The U-shape permits firing of the weapon by pressure from either thumb.

4-26. Magazine Release Latch. The magazine release latch is on the left side of the receiver. The latch spring automatically locks the magazine when it is seated in the magazine bracket. Depressing the latch handle releases the magazine.

4-27. Mount Assembly Stops, Cams, Quick-Release Pin, and Shock Cord.

The mount stops, cams, quick-release pin, and shock cord have the following functions:

a. Maximum traverse (table 4-1) of the machine gun are controlled by stops on both sides of the cam on the pintle post.

b. Maximum elevation and depression are controlled by cam surfaces on the pintle.

c. The quick-release pin (fig. 4-12) is attached by cable to the mount bracket of the mount and fastens the mount bracket to the rear bracket at the helicopter opening.

d. The shock cord (fig. 4-13) is fastened to the mount bracket and to the machine gun when stowed.

4-28. Operation — Armament Subsystem M24.

Operate the ARMAMENT SUBSYSTEM M24 as described in the following paragraphs.

4-29. Preflight Checks. The preflight check consists of the following:

1. Machine Gun M60D — Check to make sure that gun is thoroughly cleaned and lubricated, operable, and secured on the pintle with the quick-release pin (fig. 4-16).

Table 4-1. Armament Subsystem M24 Data

Effective range	1100 meters (max)
Rate of fire	550-650 rnds per min.
Length, overall	44.875 in.
Sighting	Aircraft ring and post type
Total traversing capability — left side	122°
Total traversing capability — right side	127°
Depression and elevation limits:	
Left side maximum depression	67°30'
Left side maximum elevation	7°30'
Right side maximum depression	73°
Right side maximum elevation	7°

2. Barrel — Dry and free of obstructions.

3. Gas cylinder — Plug is tight in cylinder.

4. Cover — Check for freedom of movement and security of latch.

5. Ejection control bag (fig. 4-14) — Installed and securely latched.

6. Ammunition can (fig. 4-15) — Installed on machine gun and loaded.

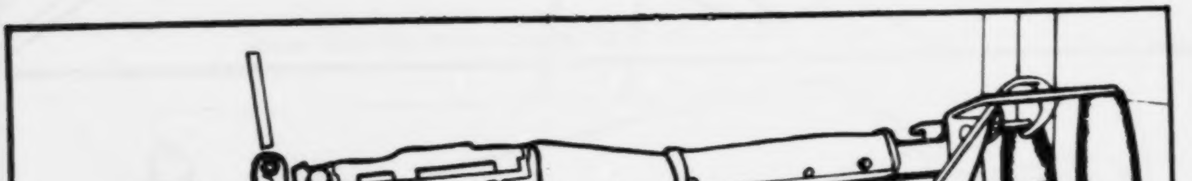


Figure 4-13. Machine Gun Stowed on Right Mount

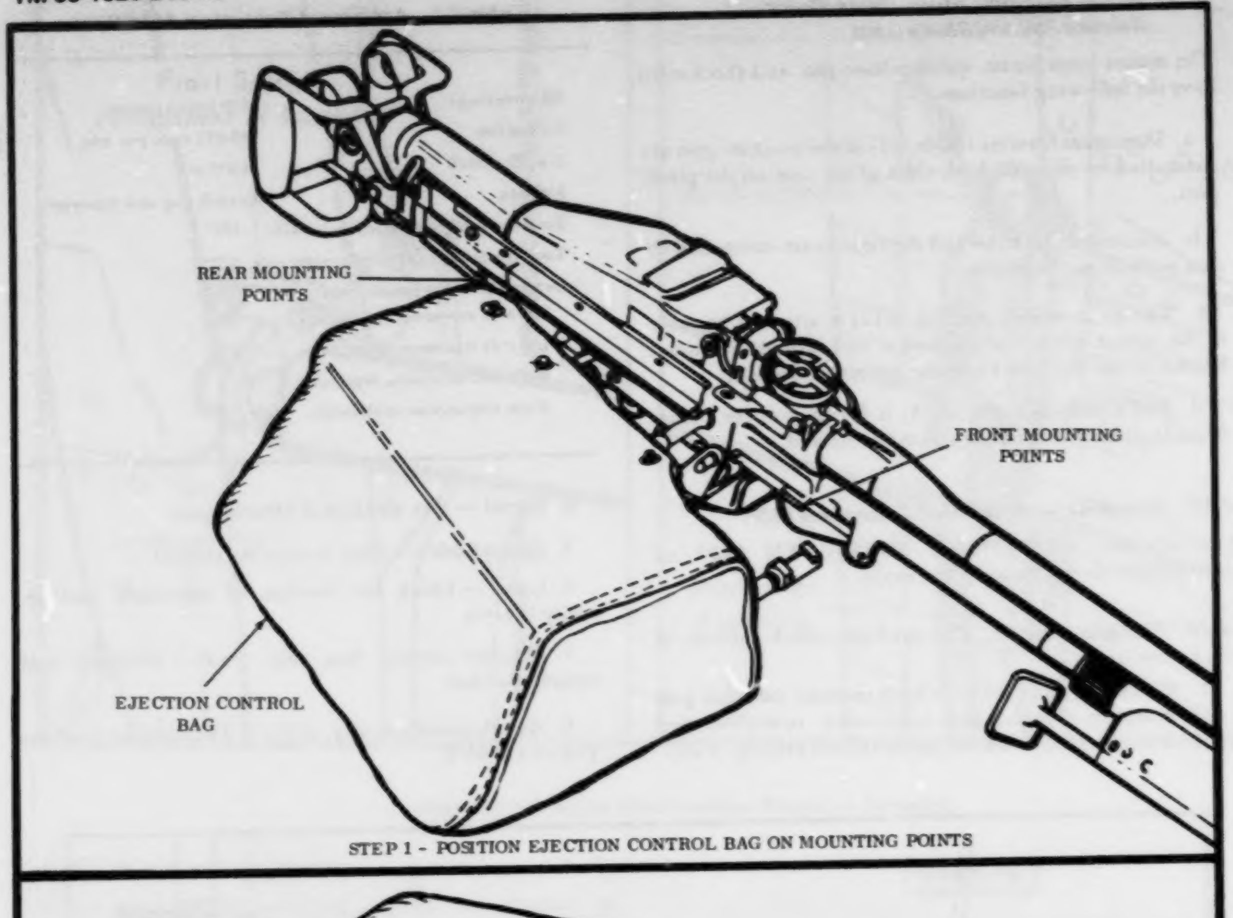

REAR MOUNTING POINTS
FRONT MOUNTING POINTS
EJECTION CONTROL BAG
STEP 1 - POSITION EJECTION CONTROL BAG ON MOUNTING POINTS
LOCK
LATCH
UNLOCKED
STEP 2 - LOCKED OR UNLOCKED POSITION
D145-317-10

Figure 4-14. Ejection Control Bag — Installed

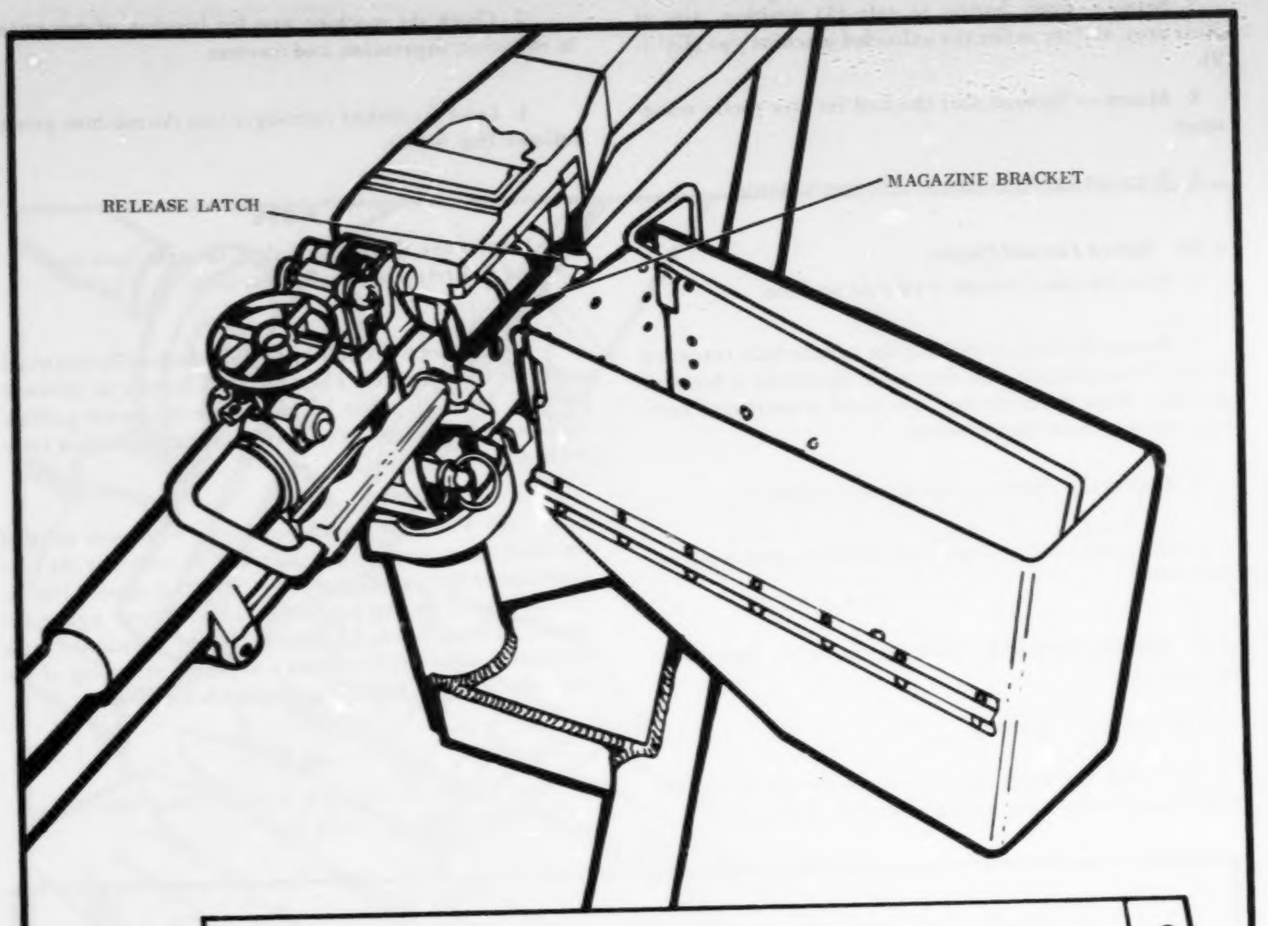

RELEASE LATCH
MAGAZINE BRACKET
AMMUNITION CAN ASSEMBLY
TO DISCARD EMPTY AMMUNITION CONTAINER, MOVE EJECTOR
D145-316-10

Figure 4-15. Ammunition Can — Installed

7. Safety — Push button to safe (S) position, aim at clear area, and try to fire the unloaded machine gun (fig. 4-9).

8. Mount — Secured and checked for free pintle movement.

9. Extra ammunition boxes — Properly stowed.

4-30. *Before Takeoff Check.*

1. Push the safety button to safe (S) position.

2. Retract the bolt by pulling the handle fully rearward until the sear engages and then push the handle to forward position. Move the cover latch rearward to horizontal position and then raise the assembly.

3. Inspect the chamber to be sure it is clear.

4. Close the cover and secure the machine gun in stowed position.

4-31. *Inflight Operation.* Inflight operation consists of the following:

a. Preparation for firing.

1. Check the machine gun to see that it is secured with a quick-release pin on the pintle (fig. 4-16).

2. Check the machine gun for freedom of movement in elevation, depression, and traverse.

3. Load the linked cartridges into the machine gun as follows: (fig. 4-17.)

NOTE

Inspect the linked cartridges to make sure they are securely positioned in the links.

(a) Retract the bolt by pulling the handle rearward until the sear engages. Then push the handle to forward position. Push the safety button to safe (S) position. Turn the cover latch rearward to horizontal position; then raise the cover.

(b) Place the linked cartridges, with open sides of the links down, on the cartridge tray. Be sure that the first cartridge to be fired is in the cartridge tray groove (fig. 4-17). The pawl in the cartridge tray will then engage the second cartridge. The cartridge must be positioned with the open side of the links down to permit stripping of the cartridge from the link. Close and latch the cover.

NOTE

The pilot will alert the gunners when there is need to fire the machine gun.

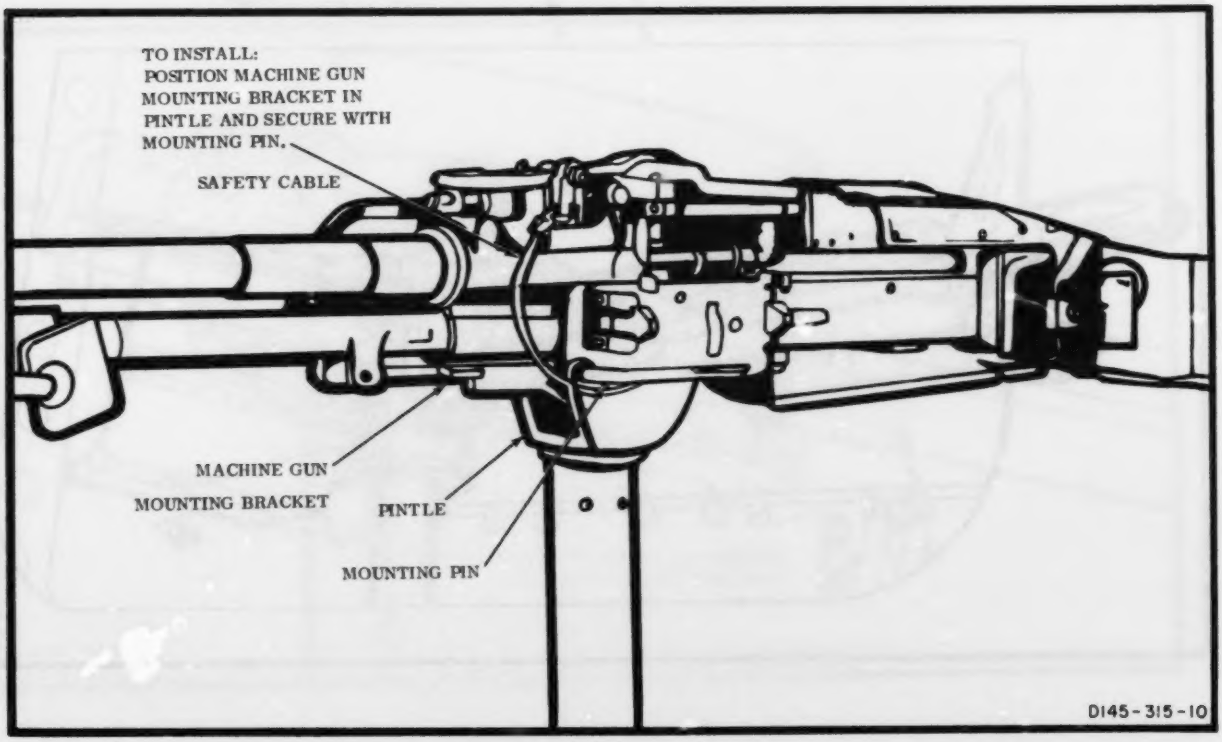
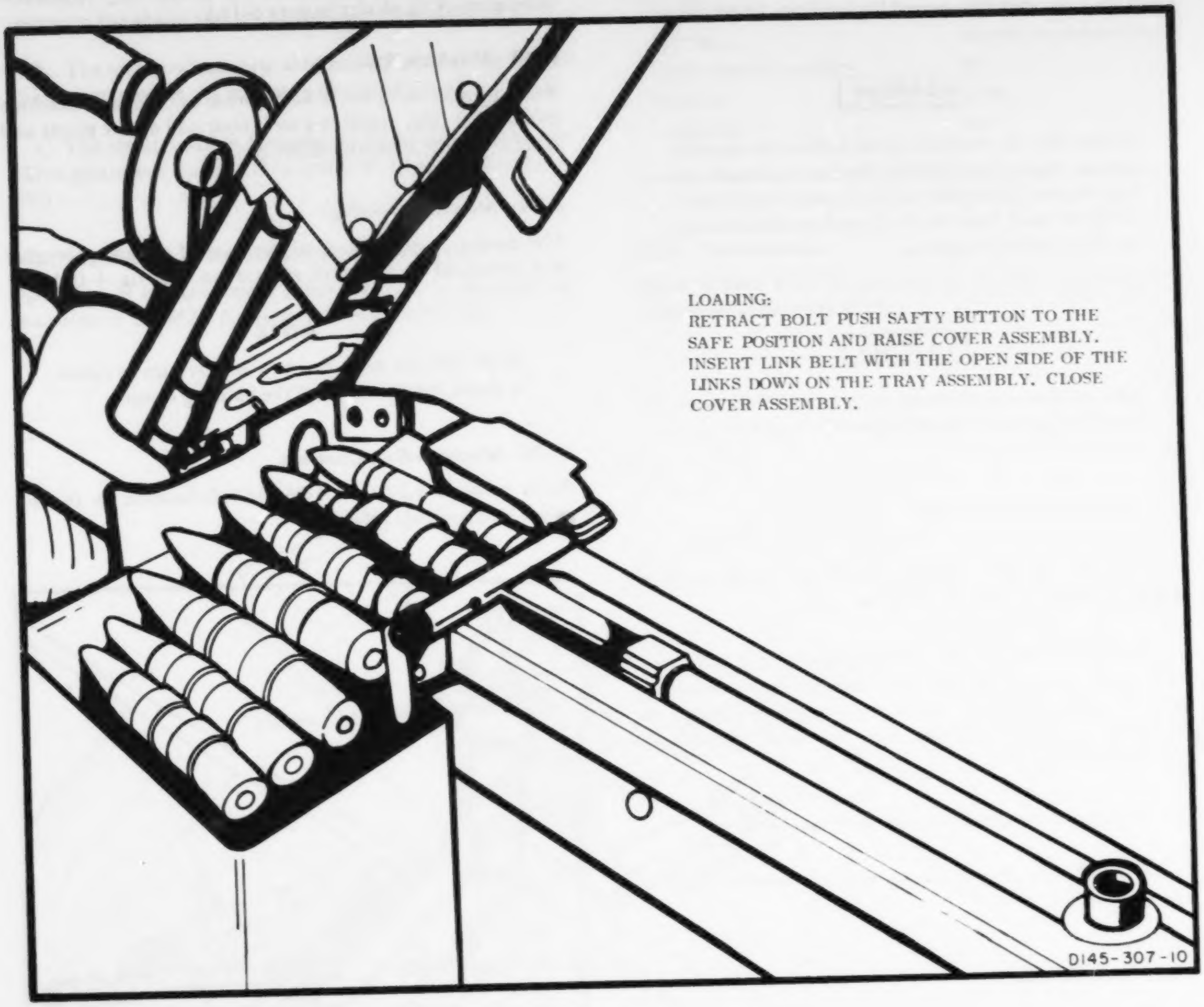

TO INSTALL:
POSITION MACHINE GUN MOUNTING BRACKET IN PINTLE AND SECURE WITH MOUNTING PIN.
SAFETY CABLE
MACHINE GUN MOUNTING BRACKET
PINTLE
MOUNTING PIN
D145-315-10

Figure 4-16. Machine Gun Positioned on Pintle — Left Side Shown



LOADING:
RETRACT BOLT PUSH SAFTY BUTTON TO THE SAFE POSITION AND RAISE COVER ASSEMBLY. INSERT LINK BELT WITH THE OPEN SIDE OF THE LINKS DOWN ON THE TRAY ASSEMBLY. CLOSE COVER ASSEMBLY.

Figure 4-17. Loading

b. Firing. With the machine gun loaded and aimed, push the safety button to fire (F) position. Because of the low rate of fire, single cartridges or short bursts can be fired. The trigger must be completely released for each shot to fire single cartridges or to interrupt firing. When the ammunition is exhausted, the last link will remain in the cartridge tray. Remove the link and the end plug by hand after the cover is opened for loading.

WARNING

Do not fire the machine guns unless the ejection control bags are installed. Failure to install the bags before firing the machine guns could cause the brass and links to be ejected overboard and ingested into the engines.

CAUTION

The machine guns are not to be fired unless rotor rpm is at ground idle or higher.

c. After Firing Operation.

1. Push the safety button to safe (S) position, aim at safe area, and try to fire the machine gun.

2. Retract the bolt by pulling the handle fully rearward until the sear engages and then push the handle to forward position. Move the cover latch rearward to the horizontal position and then raise the cover. Remove the linked cartridges.

3. Inspect the chamber to be sure it is clear.

4. Close the cover and secure the machine gun in stowed position.

4-32. Ammunition.

The ammunition for 7.62 mm machine gun M60D is classified as small arms ammunition and is issued in linked belts. Issue is in proportion by types to meet tactical requirements. (Refer to table 4-2.)

Table 4-2. Authorized Cartridges

7.62-millimeter: AP, NATO M61
7.62-millimeter: Ball, NATO M59
7.62-millimeter: Ball, NATO M80
7.62-millimeter: Tracer, NATO M62
7.62-millimeter: Dummy, NATO M63

4-33. ARMAMENT SUBSYSTEM M41.

Armament subsystem M41 is installed at the rear edge of the ramp. The mount has a pintle and post with limiting cam surfaces similar to those on armament subsystem M24 mount assembly. The machine gun, ammunition can, and ejection control bag are the same as those on armament subsystem M24. (Refer to para 4-17.)

4-34. Machine Gun.

Refer to para 4-18 for a description of 7.62 mm machine gun M60D. The machine gun is mounted on the pintle and is secured with a quick-release pin.

4-35. Mount Assembly.

The mount is positioned on the lugs of the ramp bracket and is secured with a quick-release pin. (See fig. 4-18.)

NOTE

If the bracket must be installed, be sure to center it along the rear edge of the loading ramp.

4-36. Machine Gun Controls.

Refer to para 4-20 thru 4-26 for information on the machine gun controls (M60D).

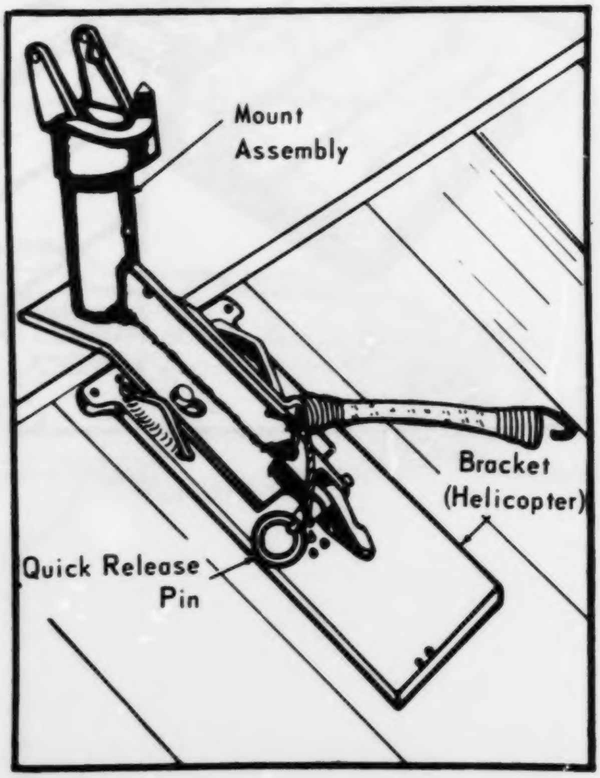


Figure 4-18. M41 Mount — Installed on Ramp

4-37. *Mount Assembly Stops, Cams, Quick-Release Pin, and Elastic Cord.* The mount stops, cams, quick-release pin, and elastic cord have the following functions:

a. Maximum traverse, elevation, and depression of the machine gun M60D are controlled by cam surfaces and stops on the pintle and the pintle post. (See table 4-3.)

b. The quick-release pin, attached by cable to the rear of the mount, secures the mount to the ramp. (See fig. 4-18.)

c. The elastic cord is fastened to the mount and the machine gun when holding it in a stowed position. (See fig. 4-19.)

4-38. Operation — Armament Subsystem M41.

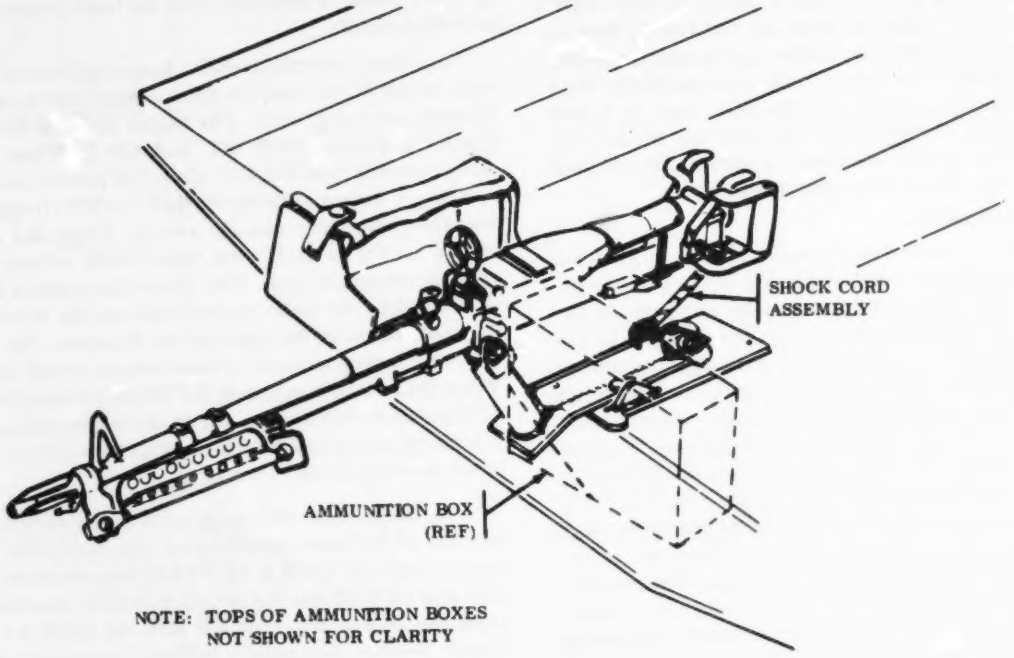
Operation of the armament subsystem M41 is the same as operation of the M24. Refer to para 4-28 thru 4-31.

Table 4-3. Armament Subsystem M41 Data

Effective range	1100 meters (max)
Rate of fire	550-650 rnds per min.
Length, overall	44.875 in.
Sighting	Aircraft ring and post type
Total traversing capability	94°
Elevation	17°30'
Depression	69°

4-39. Ammunition.

Refer to para 4-32 for information on the ammunition for armament subsystem M41.



NOTE: TOPS OF AMMUNITION BOXES NOT SHOWN FOR CLARITY

Figure 4-19. Machine Gun in Stowed Position — Right Rear View

SECTION III CARGO HANDLING SYSTEMS

4-40. Winch.

A 3,000-pound-capacity hydraulically operated winch (fig. 4-20) is mounted on the floor in the right forward cabin at sta 120. Hydraulic power to operate the winch is supplied by the utility hydraulic system. The winch (fig. 4-21) has 150 feet of 1/4-inch cable. It is capable of winching up to 12,000 pounds of cargo with the aid of pulley blocks. When used in hoisting mode, the load is limited to 600 pounds. The winch has two maximum reeling speeds: one for cargo loading (20 fpm) and one for hoisting (100 fpm). When the winch is used for cargo loading, a selector control lever on the cable drum housing is moved to CARGO. When the winch is used for hoisting, the selector control lever is moved to RESCUE. A mechanical braking device automatically locks the cable drum when power is off, preventing loss of load control thru cable payout. If the winch cable load exceeds 3,200 pounds, an overload switch will automatically stop the winch. The free end of the winch cable is equipped with a metal ball which locks into one end of a quick-disconnect device that is used to attach hooks to the cable. Both ends of the cable are painted red for 20 feet to alert the operator that the cable end is approaching. In CARGO mode, the winch will automatically stop when the cable is reeled out 150 feet, and at 3 feet when the cable is reeled in. In RESCUE mode, the winch will stop when the cable is reeled out 150 feet and at 28.5 feet when the cable is reeled in.

4-41. Winch Controls.

The winch can be controlled from the cockpit by switches on the overhead switch panel (fig. 4-22). It can also be controlled from the cargo compartment by switches on the winch/hoist control grip (fig. 4-26). The switches in the cockpit override the switches on the control grip, enabling the pilot to assume control of hoisting operations in an emergency. When operating from the cargo compartment, the winch-hoist control grip (fig. 4-26) can be plugged into a receptacle on the auxiliary control panel (fig. 4-23) at sta 95, the hoist operations panel at sta 320 (fig. 4-27), or the receptacle at sta 502 (fig. 4-24) by an extension cord. The winch can also be manually operated from the cabin. These controls are for emergency use only. The controls are mounted on the structure in the heater compartment. **Instructions for manual operation of the winch are on the structure above the control valves and in para 4-42. Electrical power to operate and control the winch is supplied by the 28-volt No. 1 dc bus thru two circuit breakers on the No. 1 power distribution panel. These two circuit breakers are marked HOIST CABLE CUTTER and HOIST CONT.**

NOTE

> **The cable cutter arming device must be plugged into the receptacle on the auxiliary control panel at sta 95 (fig. 4-23) and the cable speed selector lever must be at CARGO to complete the winch control circuit for cargo operations. The cable cutter arming device must be plugged into the receptacle on the overhead above the utility hatch (fig. 4-25) and the cable speed selector lever must be at RESCUE to complete the hoist control circuit for hoisting operations.**

a. Winch control switches (overhead switch panel).

1. Hoist master switch. A toggle hoist master switch is on the hoist control panel (fig. 4-22). The switch (labeled HOIST MASTER) has positions marked REMOTE, OFF, and PILOT. When the switch is at REMOTE, electrical power from the 28-volt No. 1 dc bus, thru the HOIST CONT circuit breaker, energizes the winch arming switch on the winch/hoist control grip. Once this switch is pressed, the winch cable switch, also on the grip, is energized, allowing the winch reeling speed to be controlled at the hoist operator's station. When the master switch is at PILOT, electrical power energizes the hoist control switch on the overhead switch panel, which gives the pilot control of the hoisting system. When the switch is at OFF, power is removed from the hoist control switches at both stations.

2. Hoist control switch. A spring-loaded, rheostat-type switch is provided for hoist control and is on the hoist control panel (fig. 4-22). The switch (labeled HOIST) has positions marked OFF, IN, and OUT. When the hoist master switch is at PILOT, electrical power, from the 28-volt No. 1 dc bus thru the HOIST CONT circuit breaker, energizes the hoist control switch. Then the switch is moved to IN or OUT, the hoist brake release solenoid valve is energized open. The open valve applies hydraulic pressure thru the hoist control valve to the winch to turn the cable drum in the appropriate direction. The speed of the cable is proportional to hoist control switch movement. When the switch is released, the switch assumes the center-OFF position. In addition, the brake release solenoid valve is deenergized closed, which removes hydraulic pressure to brake the cable drum.

3. Cable cutter switch. A cable cutter switch is on the left side of the hoist control panel (fig. 4-22). The guarded switch (labeled CABLE CUTTER) has positions marked ON and OFF. When the switch is at ON, electrical power from the 28-volt No. 1 dc bus thru the CABLE CUTTER circuit breaker, detonates a ballistic cartridge in the cable cutter which cuts the cable. When the switch is at OFF, the cable cutter circuit is deenergized.

b. Winch control switches (control grip, fig. 4-26). A portable pistol-shaped control grip contains a built-in microphone switch and a number of other switches used in hoisting, winching, and cargo hook operations. A receptacle for plugging in the extension cord is in the butt end of the grip. A hook extending from the side of the grip is used to hang the grip in its stowed position on the hoist control panel. The switches contained in the grip are as follows:

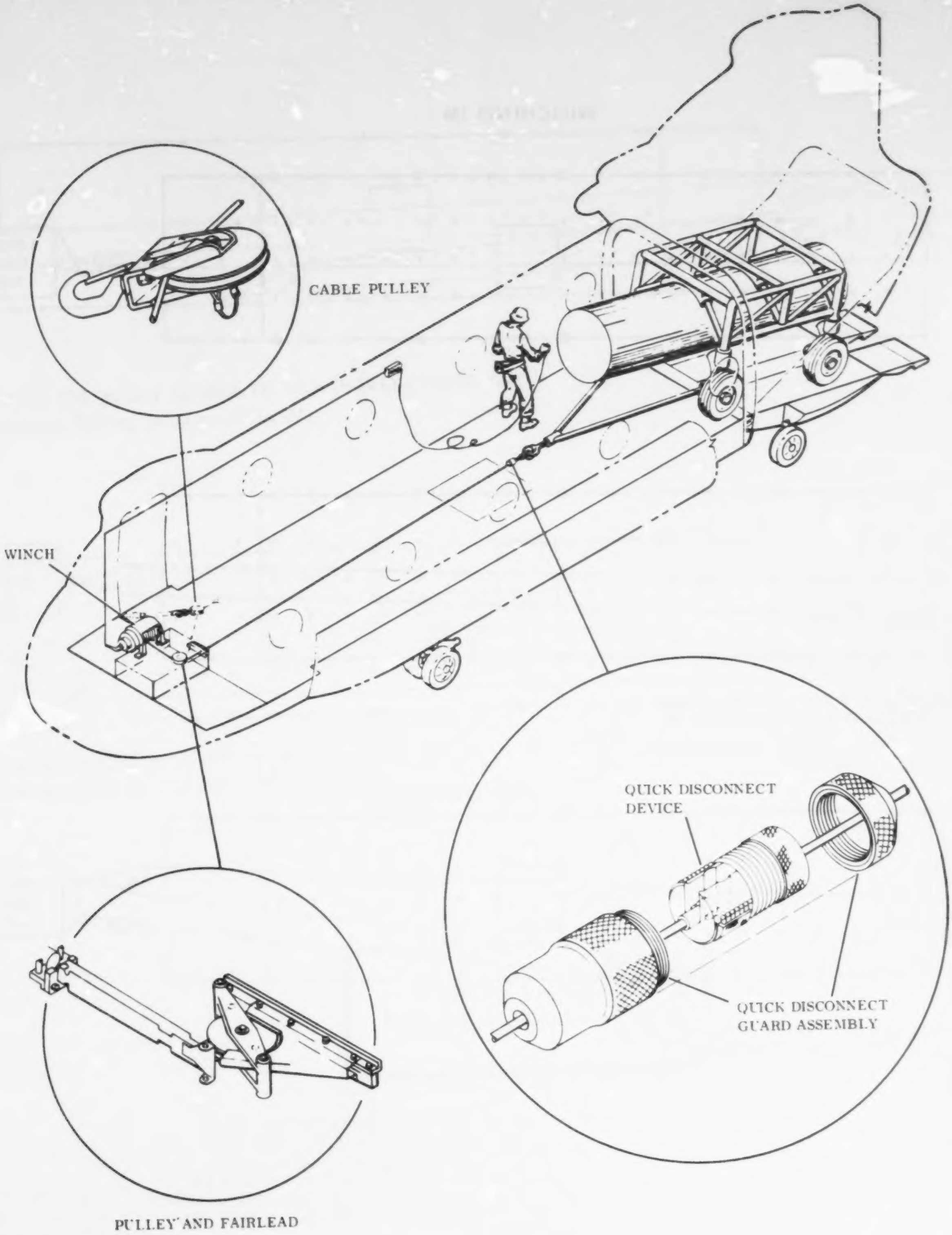
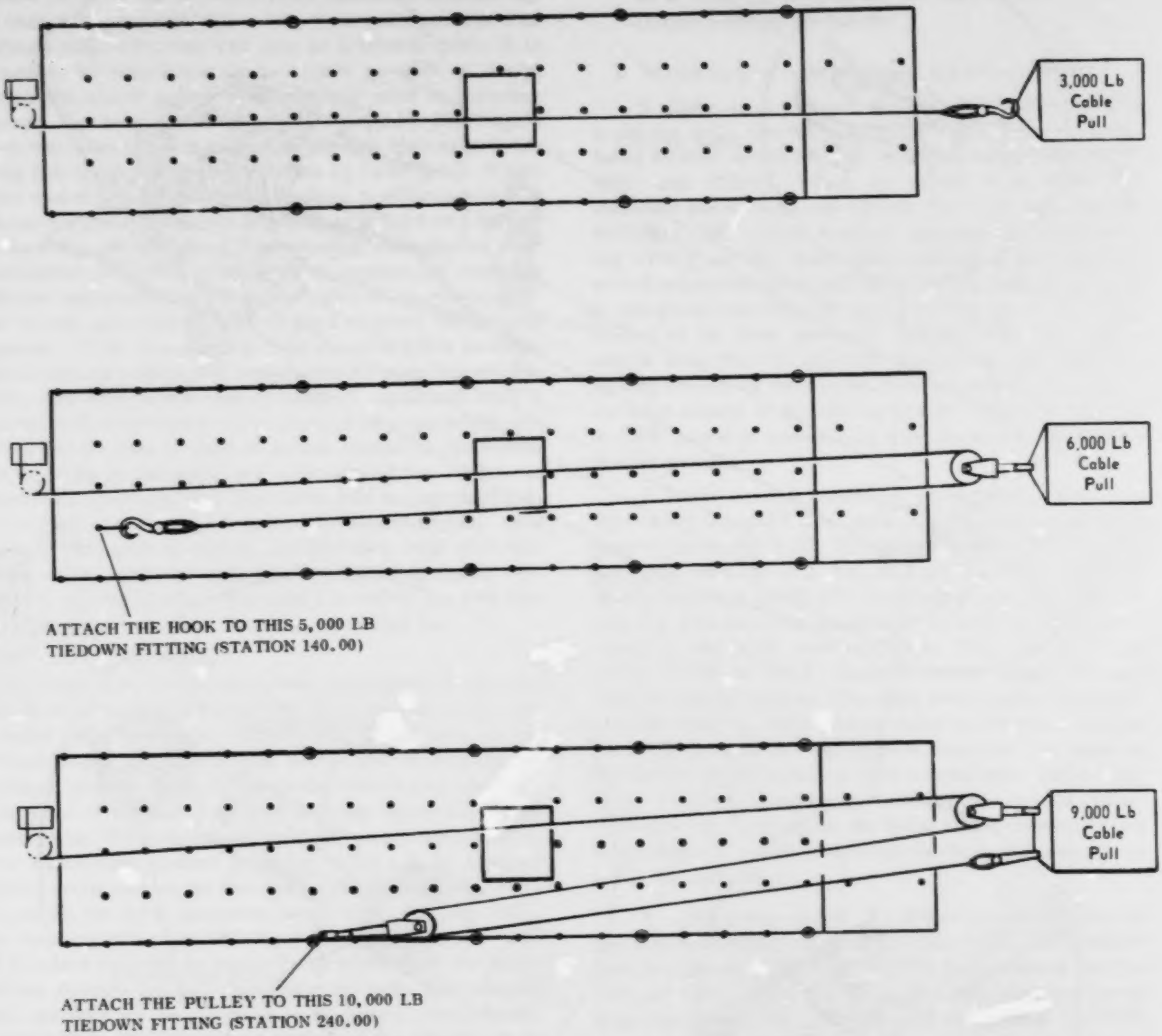

CABLE PULLEY
WINCH
QUICK DISCONNECT DEVICE
QUICK DISCONNECT GUARD ASSEMBLY
PULLEY AND FAIRLEAD
D145-128-10

Figure 4-20. Winching System

WINCHING IN


3,000 Lb
Cable
Pull
6,000 Lb
Cable
Pull
9,000 Lb
Cable
Pull

ATTACH THE HOOK TO THIS 5,000 LB TIEDOWN FITTING (STATION 140.00)

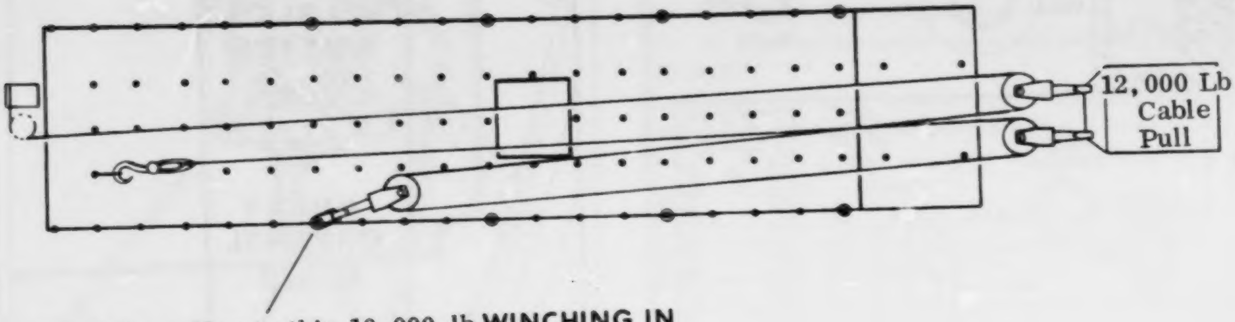
ATTACH THE PULLEY TO THIS 10,000 LB TIEDOWN FITTING (STATION 240.00)

NOTE

THE CABLE SPEED WHEN WINCHING IS 20 FEET PER MINUTE; HOWEVER THE LOAD WILL MOVE AT THE FOLLOWING RATES: 3,000 LB- - 20FEET PER MINUTE. 6,000 LB - - 10 FEET PER MINUTE. 9,000 LB - - 6.6 FEET PER MINUTE, AND 12,000 LB - - 5 FEET PER MINUTE.

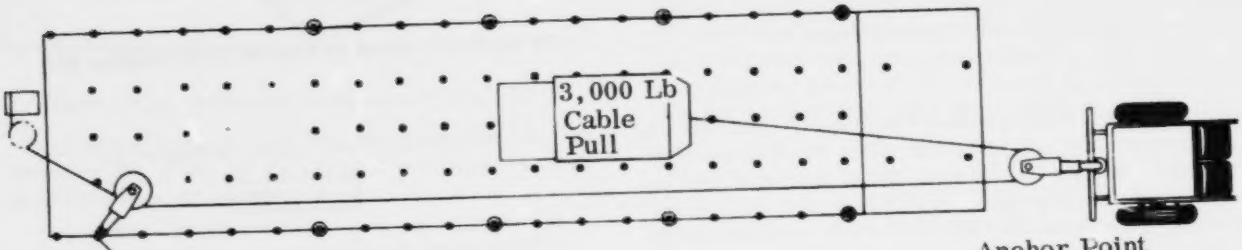
D145-129-10

Figure 4-21. Winch Capabilities (Sheet 1 of 2)


12,000 Lb
Cable
Pull

Attach the pulley to this 10,000-lb tiedown fitting (station 240.00)

WINCHING IN


3,000 Lb
Cable
Pull

Attach the pulley to this 5,000-lb tiedown fitting (station 140.00)

Anchor Point
(Tractor, Tug, etc.)

WINCHING OUT

• 5,000-Lb Tiedown Fitting
● 10,000-Lb Tiedown Fitting

Figure 4-21. Winch Capabilities (Sheet 2 of 2)

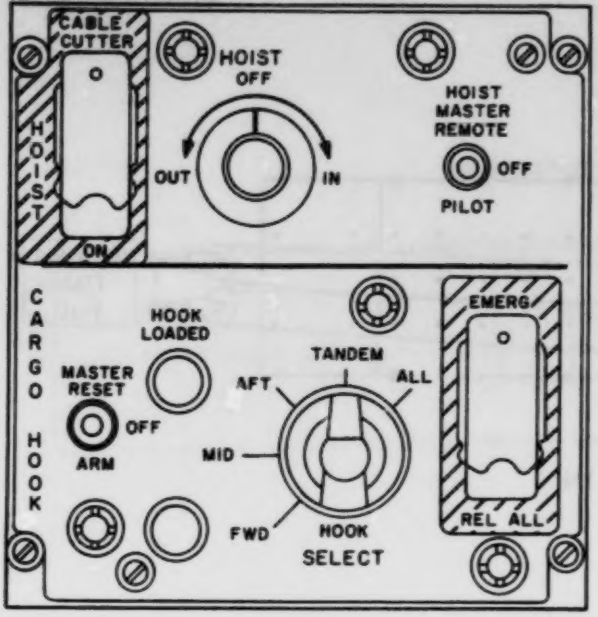


Figure 4-22. Hoist Control Panel

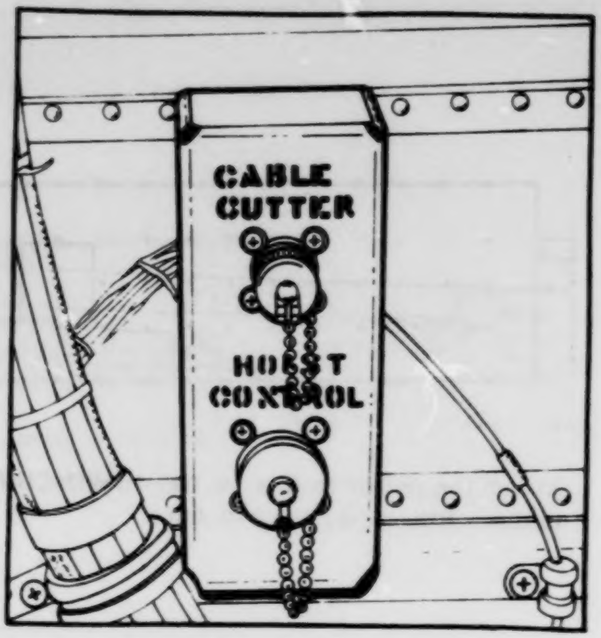


Figure 4-23. Auxiliary Control Panel (Station 95)

1. Winch arming switch. The winch is armed for use by a trigger-type, spring-loaded switch. The location of the switch on the grip is the same as that of the trigger position on a hand gun. When the switch is pressed, a circuit closes, arming the control circuits of the winch hydraulic motor. When the switch is released, the circuit opens, rendering the winch inoperable.

NOTE

The winch arming switch must be pressed to operate the winch.

2. Winch cable switch. Winch cable reeling is controlled by a rotary switch on the left side of the control grip. Action markings around the switch are IN, OFF, and OUT. The switch is spring-loaded to center OFF position. When the switch is moved in IN or OUT direction, a selector valve in the winch hydraulic system is electrically actuated, providing hydraulic pressure to turn the cable drum. The speed of the cable is proportional to cable switch movement in either direction.

3. Cable cutter switch. A pushbutton switch on the upper shoulder of the control grip actuates the cable cutter. A metal guard marked CABLE CUTTER prevents accidental closing of the switch. When pressed, the switch closes a circuit, providing electrical current to fire a ballistic cartridge in the cable cutter. The firing propels a cutter which cuts the cable.

4. Cargo hook release switch. (Refer to para 4-53.)

5. Microphone switch. (Refer to chapter 3.)

CAUTION

When using the microphone switch on the hoist control grip, be careful not to press the cargo hook switch.

4-42. Winch Operation.

With hydraulic and electrical power available, the winch can be operated from the cockpit or from the cargo compartment, in either the cargo mode (for winching cargo into the cargo compartment via the ramp) or in the rescue mode (for rescue or hoisting small cargo thru the rescue hatch).

a. Control settings and electrical connections for operating the winch in the cargo mode from the cockpit are as follows:

1. Cable speed selector lever on the winch — CARGO.
2. Cable cutter arming device — Plugged into the auxiliary control panel, in the heater compartment at sta 95.
3. Hoist master switch on the cockpit overhead panel — PILOT.
4. Hoist control switch on cockpit overhead panel — OUT, OFF, or IN as required to control direction and speed of cable.

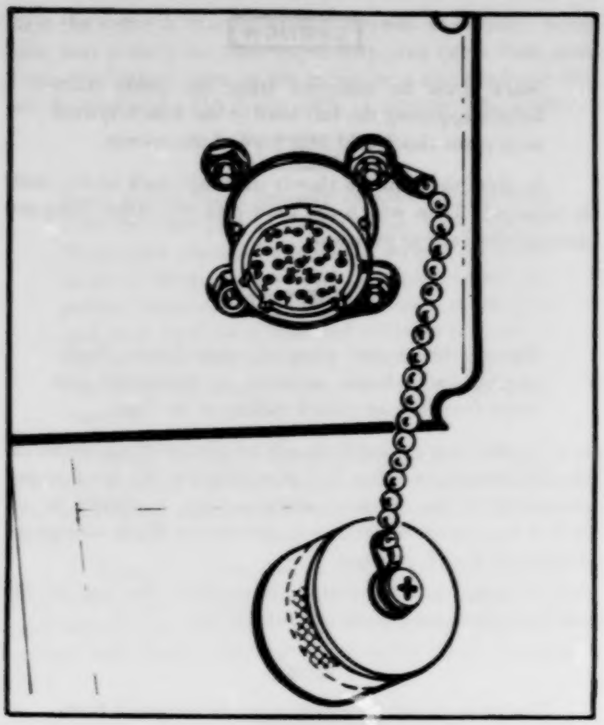


Figure 4-24. Winching Receptacle (Station 502)

b. Control settings and electrical connections for operating the winch in the cargo mode from the cargo compartment are as follows:

1. Cable speed selector lever on the winch — CARGO.

2. Cable cutter arming device — Plugged into the auxiliary control panel, in the heater compartment at sta 95.

3. Hoist master switch on the cockpit overhead panel — REMOTE.

4. Winch/hoist control grip — Plugged into either the auxiliary control panel in the heater compartment, sta 95, the hoist control panel, right side sta 320, or the receptacle, left side sta 502.

5. Winch arming switch on the winch/hoist control grip — Depress.

6. Winch cable switch on the winch/hoist control grip — OUT, OFF, or IN as required to control direction and speed of winch cable.

c. Control settings and electrical connections for operating the winch in the rescue mode from the cockpit are as follows:

1. Cable speed selector lever on the winch — RESCUE.

2. Cable cutter arming device — Plugged into the overhead receptacle above the rescue hatch.

3. Hoist master switch on the cockpit overhead panel — PILOT.

4. Hoist cable switch on the cockpit overhead panel — OUT, OFF, or IN as required to control the direction and speed of the winch cable.

d. Control settings and electrical connections for operating the winch in the rescue mode from the cargo compartment are as follows:

1. Cable speed selector lever on the winch — RESCUE.

2. Cable cutter arming device — Plugged into the overhead receptacle above the rescue hatch.

3. Hoist master switch on cockpit overhead panel — REMOTE.

4. Winch/hoist control grip — Plugged into the receptacle on the hoist control panel, right side, sta 320.

5. Winch arming switch on the winch/hoist control grip — Depress.

6. Winch cable switch on the winch/hoist control grip — OUT, OFF, or IN as required to control direction and speed of the winch cable.

e. Rigging and operating procedures for use of the winch in the cargo mode are as follows:

1. Using the hoist control switch on the cockpit overhead panel or on the winch/hoist control grip — reel out the winch cable as required for rigging. As the cable is being reeled out, a crewman should maintain tension on the cable to avoid snarling and kinking. After the cable is extended the usable cable length will be checked to ensure that the cable is free of any broken strands or definite bends that may reduce the cable capability. Any cable with more than one broken wire in 60 inches or a distinct bend will not be used and a DA Form 2408-13 entry will be made.

CAUTION

Do not exceed 3,000 pounds single line pull. Overload will result in the winch overload switch actuating to stop the winch.

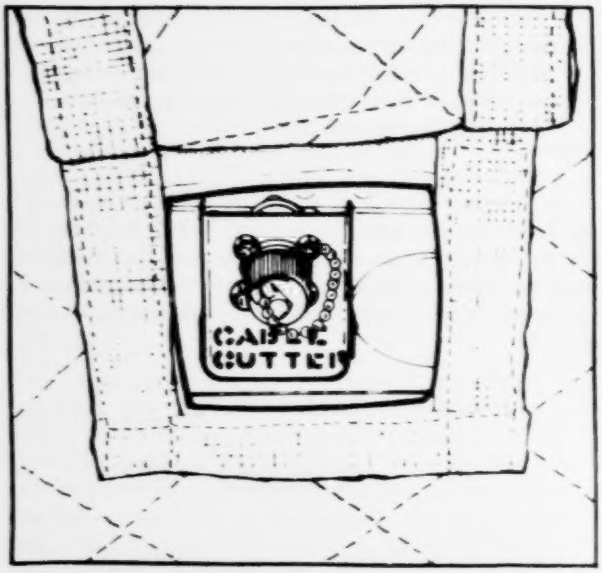


Figure 4-25. Overhead Cable Cutter Receptacle

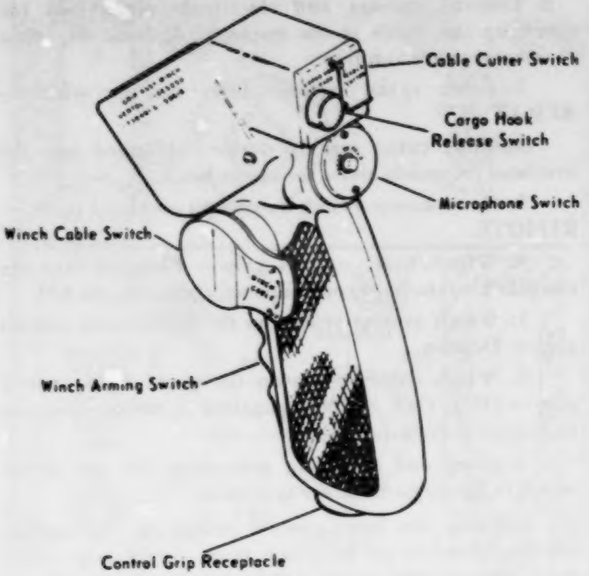


Figure 4-26. Winch/Hoist Control Grip

2. Remove the pulley from the pulley blocks by removing the quick-release pins. Reeve the cable thru pulley as required to provide the required pull and angle of entry (fig. 4-21) for rigging configurations for various loads. Install the pulley blocks and secure them with the quick-release pins.

WARNING

The cable quick disconnect cover guard must be installed during all cargo operations. Otherwise, the hook assembly can be inadvertently disconnected from the winch cable which can result in serious injury to personnel.

3. Attach the winch cable to the cable hook assembly by depressing the lock rings on each end of the quick disconnect device, inserting the ball ends of the winch and hook assembly cables into the quick disconnect device and releasing the lock rings. Install the quick disconnect cover guard.

4. Attach the winch cable to the load.

WARNING

Personnel not required for the winching operation must remain well clear of the winch cable to prevent possible injury should the cable break.

CAUTION

Slack must be removed from the cable train before applying the full load to the winch system to prevent shock and over load of the system.

5. Reel the cable in slowly until all slack in the cable is removed. Then winch the load into the cargo compartment to the desired position.

WARNING

Chock vehicles and wheeled cargo before disengaging cable hook. Injuries to personnel can result from uncontrolled rolling of the load.

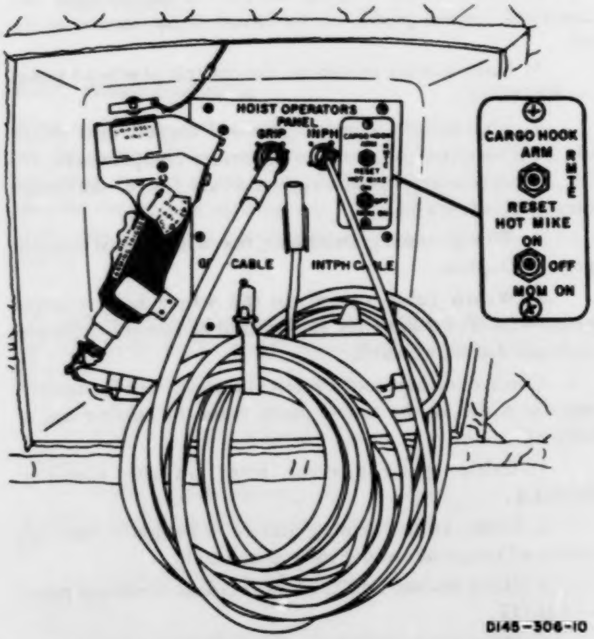
6. Reel out the cable slowly to provide slack in the cable. The hook can either be left attached to the load or disconnected. If the hook is disconnected, it should be attached to a tie-down fitting to prevent in-flight vibrations damage to the cargo floor.

f. Rigging and operating procedures for use of the winch in the rescue mode are as follows:

NOTE

The cargo hook assembly must be removed from the rescue hatch.

1. Using the hoist control switch on either the cockpit overhead panel or on the winch/hoist control grip, reel out the winch cable as required for rigging. As the cable is being reeled out, a crewman should maintain tension on the cable to avoid snarling and kinking. After the cable is extended the usable cable length will be checked to ensure



DI45-306-10

Figure 4-27. Hoist Operators Panel (Station 320)

that the cable is free of broken strands or definite bends that may reduce the cable capability. Any cable with more than one broken wire in 60 inches or a distinct bend will not be used and a DA Form 2408-13 entry will be made.

CAUTION

> Some pulley block assemblies have flanges with cable retainer pins as shown in fig. 4-28, sheet 2. These pins should be installed only if the cable makes a wrap angle of 180° or more around the pulley. Otherwise, the cable will bind on the pins and over load the winch and cable. When not in use, the pins and attaching hardware should be stowed in the container provided for the hoist accessories.

2. Install the pulley block assembly on the floor at sta 140, the overhead on the aft face of sta 120 bulkhead and the cable cutter pulley block over the rescue hatch. (See fig. 4-28.)

3. Reeve the cable thru the pulley at each location by first removing the quick-release pin, removing the pulley and positioning the cable over the pulley. Reinstall each pulley and secure with the quick-release pin. (See fig. 4-28.)

WARNING

> The quick-disconnect cover guard must be installed during rescue and cargo operations. Otherwise, the hook assembly can be inadvertently disconnected from the winch cable which can result in loss of life or the load or serious injury to operating personnel. For personnel rescue, the cable must touch the ground or water prior to touching personnel or a dangerous static electrical shock may result.

4. Attach the winch cable to the cable hook assembly by depressing the lock rings on each end of the quick disconnect device, inserting the ball ends of the winch and hook assembly cables into the quick disconnect device and releasing the lock rings. Install the quick disconnect cover guard.

WARNING

> Slack must be removed from the cable train before applying the full load to the winch system to prevent shock and overload of the system and possible injury to the person being hoisted.

CAUTION

> Ensure that the load is clear of the ground and all obstacles before proceeding from hover to forward flight. Do not exceed 600 pounds. An overload can result in damage or failure of the support structure for the overhead cable pulley.

5. Reel the cable out and attach the cable hook to load — Reel in or out as required.

g. When electrical power to the winch is not available, the winch may be operated in emergency mode as follows:

CAUTION

> When the winch is operated in emergency mode, the cable limit switches are disabled. To avoid kinking the cable, stop the winch when there is no less than 3 turns of cable on the drum. Stop reeling the cable in when the spring bumper contacts the levelwind fairlead.

1. Break the shear wire on the handle of the winch control valve.

2. Push in the plunger on the winch shutoff valve and rotate it to lock the valve open.

3. Turn the knurled knob on the winch control valve clockwise to reel the cable out or counterclockwise to reel it in. Return the knob to the center (detent) position to stop the winch.

4. When use of the winch is completed, turn the plunger on the winch shutoff valve to unlock and extend it.

4-43. Winching Accessories.

Accessories are provided for winching and hoisting operations. Employment of these accessories is determined by winch usage. A compartment bag is attached to the bulkhead wall above the winch for stowage of winching accessories.

a. Cable pulleys. A sufficient number of pulleys are provided to permit routing the winch cable for winching and hoisting operations. The pulleys are equipped with snap-lock fasteners for attachment to tiedown fittings or shackles as required.

b. Cable hook. A 2-ton-capacity removable hook is provided for use in winching and hoisting operations. Extending from the hook is a length of ¼-inch cable, equipped with a metal ball which locks into a quick-disconnect device that is used for attaching the hook to the cable. The full-swiveling hook contains a spring snap lock to prevent opening of the hook and accidental loss of cargo.

c. Quick-disconnect device. The quick-disconnect device permits rapid connecting and disconnecting of winch cable hooks. The device consists of a short length of steel with socket cavities at each end. The sockets are enclosed by spring-loaded rings that rest against flared rims on either edge of the device. The lockrings are depressed to admit the ball ends of the cables into the sockets and snap into place when released, securing the ball ends of the cables in a positive connection. A guard is supplied with the quick-disconnect device. When installed, it prevents the hoist operator from inadvertently operating the quick-disconnect device when assisting a rescued person into the helicopter.

d. Cable cutter. In hoisting operations, there is always a possibility that the cable hook might snag, resulting in critical strain on the hoisting system and restriction of helicopter mobility. The cable cutter provides a means of quickly severing the snagged hook by cutting the cable. The cable cutter consists of a housing, two follower rollers that permit free travel of cable thru the housing, a cutting shell, a ballistic cartridge, and a threaded receptacle for an electrical connector. The cutter housing is split to allow reeving the cable and is bolted to a pulley bracket thru two holes in the housing. The cable cutter is armed by coupling an arming device to the receptacle in the cutter housing and plugging the device into the receptacle above the utility hatch marked CABLE CUTTER. The cable cutter cartridge is to be checked for total time prior to any hoisting or rescue operations. The cartridge should not be used after 8 years from date of manufacture and should also be replaced after 1 year of installed service life. Cartridges are considered over age when either limit is exceeded.

WARNING

If personnel are in the cabin fuselage section when a load is jettisoned, make sure that they remain aft of the rescue hatch and face away from the cable cutter. The hoist cable can whip forward when it is cut and particles can be ejected from the cable cutter.

e. Cable cutter arming device. The arming device consists of an electrical wiring harness with electrical connectors at either end. This device is used to arm the cable cutter during hoisting operations. A connector at one end of the device couples with the threaded receptacle in the cable cutter; the connector at the other end of the device plugs into a receptacle above the utility hatch and is labeled CABLE CUTTER. (See fig. 4-25.)

f. Extension cord. A 15-foot extension cord is provided to allow mobility of the winch or hoist operator. Electrical connectors at each end of the cord connect with receptacles in the winch control grip and in the hoist control panel. This cord is the only means of plugging in power to the switches on the control grip.

g. Safety harness. A safety harness is provided for the hoist operator in operations involving the use of the rescue hatch. The harness permits complete freedom of movement while affording a measure of safety in preventing the wearer from falling thru the door opening. The safety harness is attached to a fitting on the wall of the cargo compartment near the hoist control panel, a tiedown fitting, or static line.

4-44. Hoisting System

The hoisting system (fig. 4-28) is used for air rescue and for aerial loading of smaller general cargo thru the utility hatch. The hoisting system differs from the winching system only in the manner in which the cable is reeved and the mode selected at the winch. Hoisting operations require the winch cable to be reeved overhead and the hoist load capacity to be limited to a maximum of 600 pounds. The winch cable hook is used for hoisting operations together with the cable cutter which provides for quick release of the paid out cable and hook in event of emergency. On those aircraft provided with pulley block assemblies having pins as shown in fig. 4-28, sheet 2, the following instructions apply: When the hoisting system is reeved as shown in fig. 4-28, sheet 1, the pins and their retaining hardware are to be installed only if the cable makes a wrap angle of 180° or more around the pulley. When not in use, the pins and their retaining hardware are to be stowed in the container provided for hoist accessories. The cargo hook assembly must be removed from the utility hatch before engaging in operations requiring use of the hoisting system.

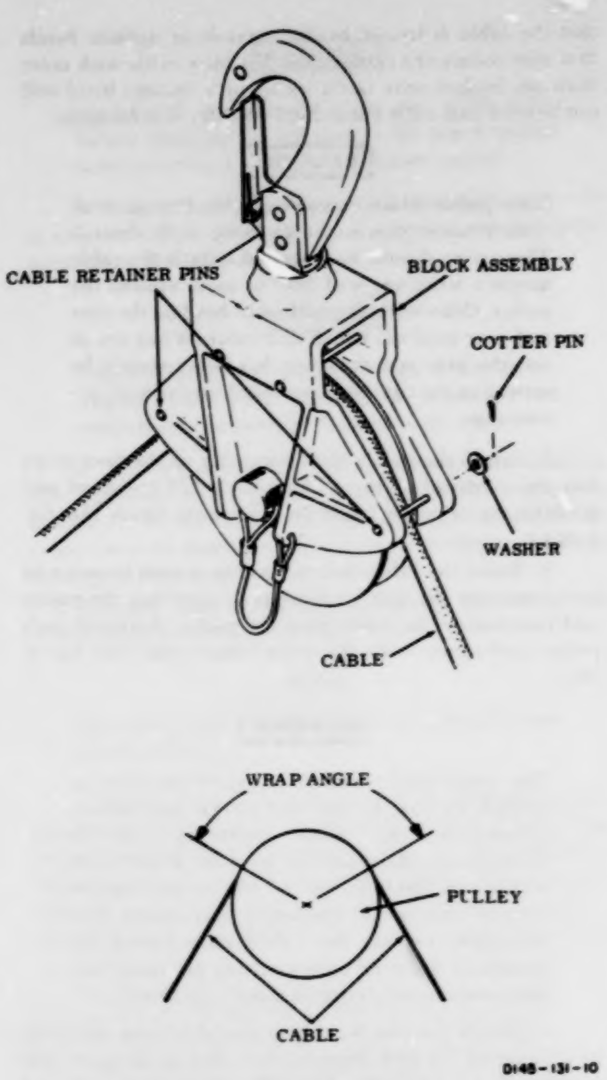


Figure 4-28. Hoisting System (Sheet 1 of 2)

4-45. Hoist.

(Refer to para 4-40.)

4-46. Hoist Controls.

(Refer to para 4-41.)

4-47. Hoist Control Switches.

(Refer to para 4-41 a. and b.)

4-48. Hoist Operation.

(Refer to para 4-42.)

WARNING

To prevent dangerous electrical shock to personnel being hoisted, the cable must touch the ground or water prior to contacting personnel.

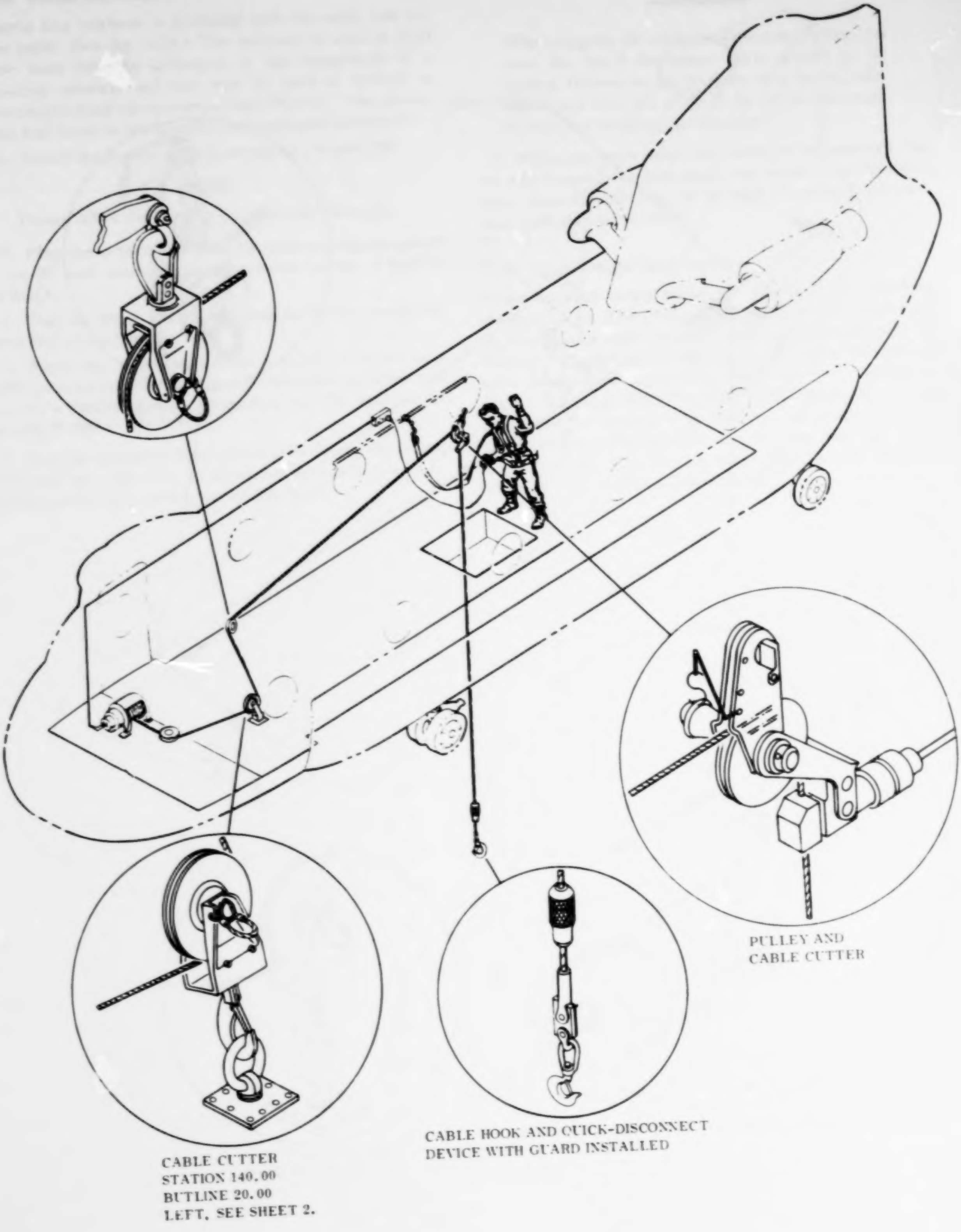

PULLEY AND
CABLE CUTTER
CABLE HOOK AND QUICK-DISCONNECT
DEVICE WITH GUARD INSTALLED
CABLE CUTTER
STATION 140.00
BUTLINE 20.00
LEFT, SEE SHEET 2.

Figure 4-28. Hoisting System (Sheet 2 of 2)

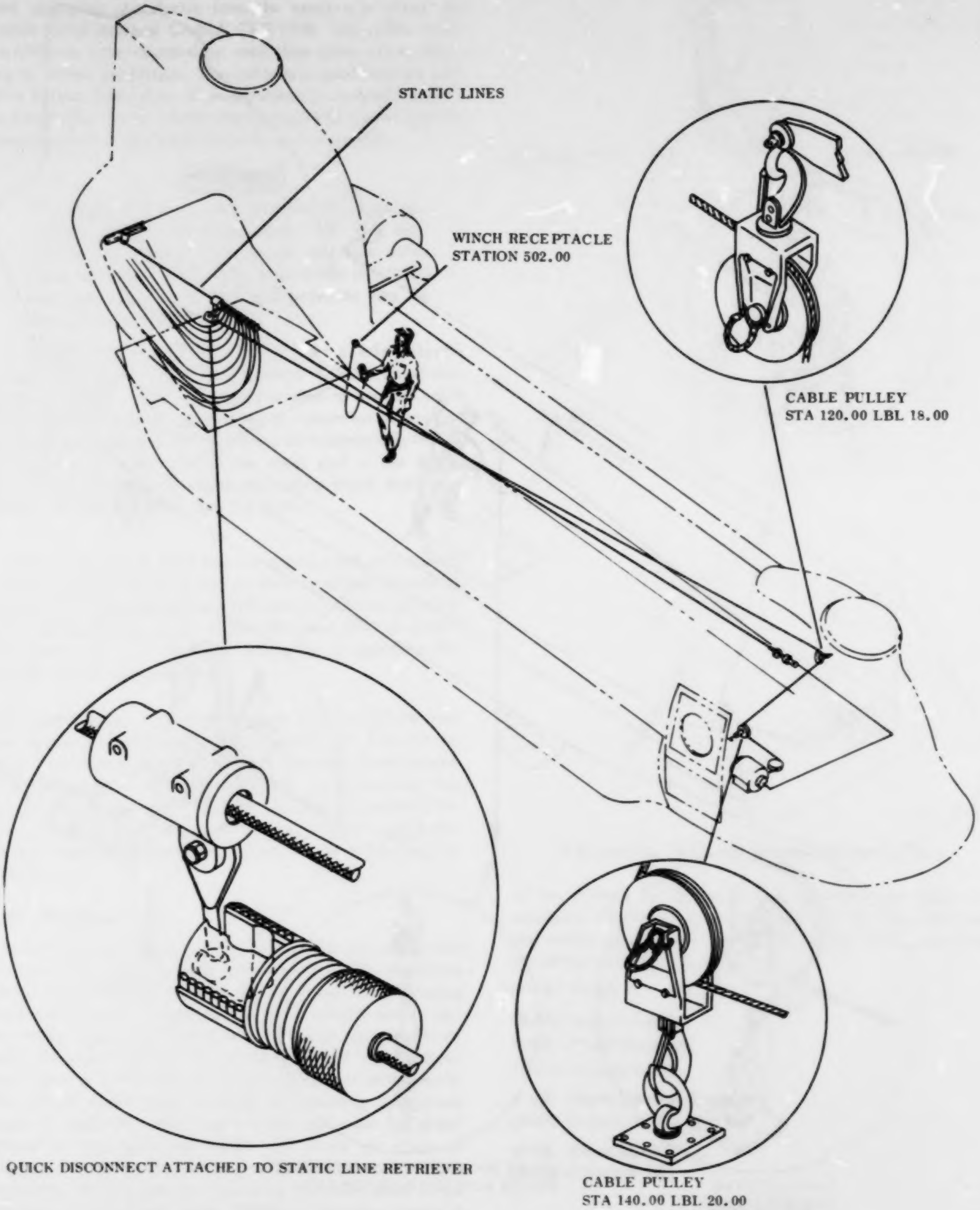

STATIC LINES
WINCH RECEPTACLE
STATION 502.00
CABLE PULLEY
STA 120.00 LBL 18.00
QUICK DISCONNECT ATTACHED TO STATIC LINE RETRIEVER
CABLE PULLEY
STA 140.00 LBL 20.00

Figure 4-29. Static Line Retriever System

4-49. Static Line Retriever.

A static line retriever is provided with the static line anchor cable. (See fig. 4-29.) The retriever is used to haul static lines into the helicopter at the completion of a paradrop mission and can also be used to haul in a paratrooper ***hung up*** on a static line. The static line anchor cable and retriever are installed and operated as follows:

a. Install the anchor cable between sta 120 and 592.

NOTE

Do not allow the cable to sag more than 6 inches.

b. Plug the cable cutter into the auxiliary control panel at sta 95 and move the speed selector on the winch to CARGO.

c. Plug the winch control grip into the power receptacle at sta 502 on the left side.

d. Reeve the winch cable thru a pulley attached to a 5,000-pound tiedown fitting at sta 140, buttline 20 left and then thru another pulley attached at sta 120, buttline 18 left (fig. 4-29).

e. Reel out enough cable to allow the cable to rest on the floor and out of the way of personnel. Attach a quick-disconnect and cover guard to the winch cable.

WARNING

When rigging the cable to retrieve static lines, be sure the quick-disconnect cover guard is installed. Otherwise, the retriever may become disconnected from the cable if the retriever is used to haul in a hung-up paratrooper.

f. When the static lines are ready to be retrieved, reel out additional cable and attach the retriever to the winch cable. Reel in sufficient cable; then disconnect the static lines from the anchor cable.

4-50. Triple Cargo Hook System.

Three external cargo hooks are provided for attaching external cargo. The hooks can be used with a single load on one hook, two hooks in tandem (forward and aft hooks), or individual loads on three hooks. the tandem hook configuration provides improved load stability at higher airspeeds. With the triple hook system, up to three loads can be deposited at different locations during a single mission. The forward hook is at sta 249. The center hook is at sta 331. The aft hook is at sta 409. Refer to Chapter 5 for cargo hook limitations.

WARNING

> If the DUAL HOOK FAULT light indicates a malfunction of the forward or aft hook, releasing the load using other than the manual release handle is prohibited.

All hooks have normal release modes, emergency release modes, and manual release modes. Normal release mode can be controlled by both pilot's or by the hoist operator. Emergency release of all hooks can be performed electrically by either pilot or manually by the hoist operator.

4-51. Center Cargo Hook.

A center cargo hook (fig. 4-30) is provided for attaching external loads. The position of the center cargo hook is such that the load is suspended beneath the center-of-gravity of the helicopter at sta 331. The hook assembly consists of a hook, hydraulic actuator, and a release mechanism. The hook is suspended by means of a beam which is mounted inside the rescue hatch. This beam rotates within its mounting supports for longitudinal swing. The hook pivots about its attachment bolt for lateral swing. The cargo hook system is normally operated hydraulically by pressure from the utility hydraulic system. In the event of a loss in utility system pressure, the cargo hook can be opened pneumatically or manually. The cargo hook contains a spring-tensioned keeper which prevents accidental loss of cargo thru slippage of the sling rings. When not in use, the cargo hook can be removed from the hatch since both the electrical and hydraulic lines are equipped with quick-disconnectors or the cargo hook can be stowed (fig. 4-31). The cargo hook and beam assembly must be removed for rescue operations thru the hatch.

4-51.1. Center Cargo Hook Loading Pole.

WARNING

> Make sure the ground cable is connected. With the rotors turning, static potential between the helicopter and a load on the ground can be as high as 40,000 volts.

A cargo hook loading pole is provided for picking up the sling loop of external cargo loads from inside the helicopter. The loop is then placed on the cargo hook by hand. The pole has a hook at one end and a cable at the other end. The cable is attached to the fuselage to prevent accidental loss of the pole when in use and to provide a discharge path for static electricity. When not in use the pole is stowed on the lower right side of the cabin at about sta 360, (fig. 4-29.1).

4-52. Forward and Aft Cargo Hooks.

The forward and aft cargo hooks (fig. 4-32) are attached to the bottom centerline of the helicopter at sta 249 and 409. Unlike the center hook, these hooks are not accessible to the crew in flight. Both hooks have electrical normal and emergency release mechanisms. The normal mechanisms can be operated by either pilot or by the hoist operator. In an emergency, both hooks can also be released from the cockpit thru a dedicated emergency release circuit or manually by the hoist operator. A knurled knob on the side of each hook allows the hook to be opened by a ground crewman. A spring-loaded keeper prevents accidental loss of cargo thru slippage of sling rings. Each hook has a hook-loaded sensor. The sensor will close and light a hook loaded advisory light when the hook load exceeds approximately 150 pounds. Stops on the hook allow the hook to swing approximately 80° between full forward and full aft and approximately 50° full right to full left.

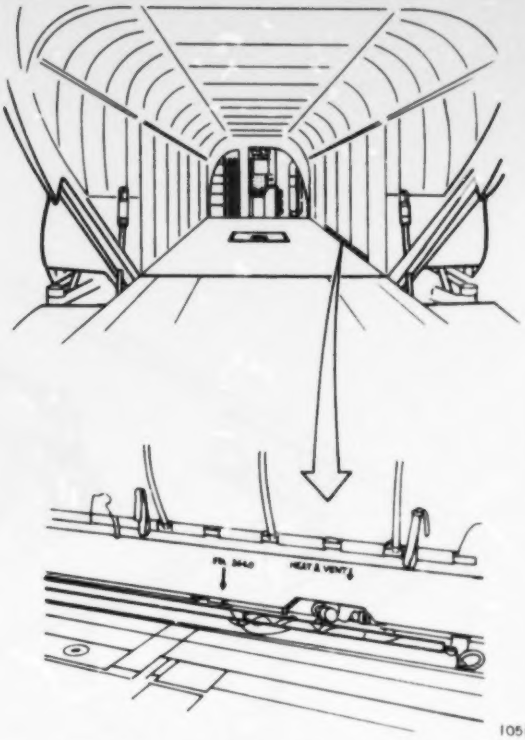


Figure 4-29.1. Center Cargo Hook Loading Pole (Typical)

4-53. Cargo Hook Controls.

The cargo hook control can be operated from the cockpit by a switch on each cyclic stick grip (fig. 2-3) and switches on the overhead panel (fig. 4-22). The hooks can be operated from the cargo compartment by a switch on the winch/hoist control grip (fig. 4-26) and switches on the hoist operators panel (fig. 4-27). Normal power to control the cargo hook system is supplied by the 28-volt No. 2 dc bus, thru the CARGO HOOK NORM RELEASE PWR and CONT circuit breakers on the No. 2 power distribution panel. Power to operate and control the emergency release is provided by the 28-volt dc essential bus thru the CARGO HOOK EMER RELEASE PWR and CONT circuit breakers on the No. 1 power distribution panel.

a. Cargo hook master switch. The CARGO HOOK MASTER switch is on the CARGO HOOK panel (fig. 4-22) of the overhead panel. The switch has three positions marked, ARM RESET and OFF. When the switch is set to ARM, power is applied to the CARGO HOOK RELEASE switches on the cyclic sticks and also to the CARGO HOOK ARMING switch at the hoist operator's station.

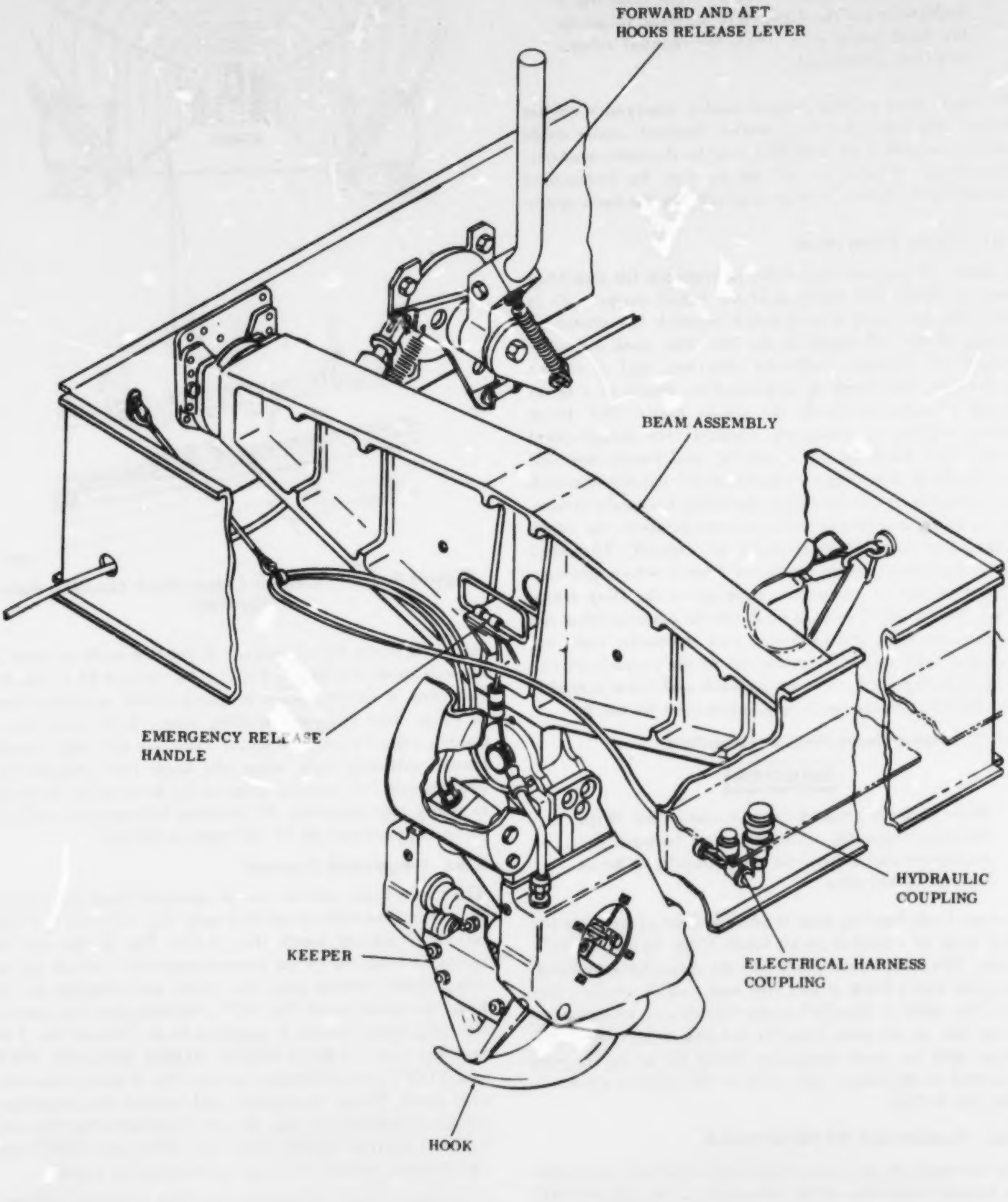

FORWARD AND AFT
HOOKS RELEASE LEVER
BEAM ASSEMBLY
EMERGENCY RELEASE
HANDLE
HYDRAULIC
COUPLING
KEEPER
ELECTRICAL HARNESS
COUPLING
HOOK
0145-98-10

Figure 4-30 Center Cargo Hook and Tandem Hook Release

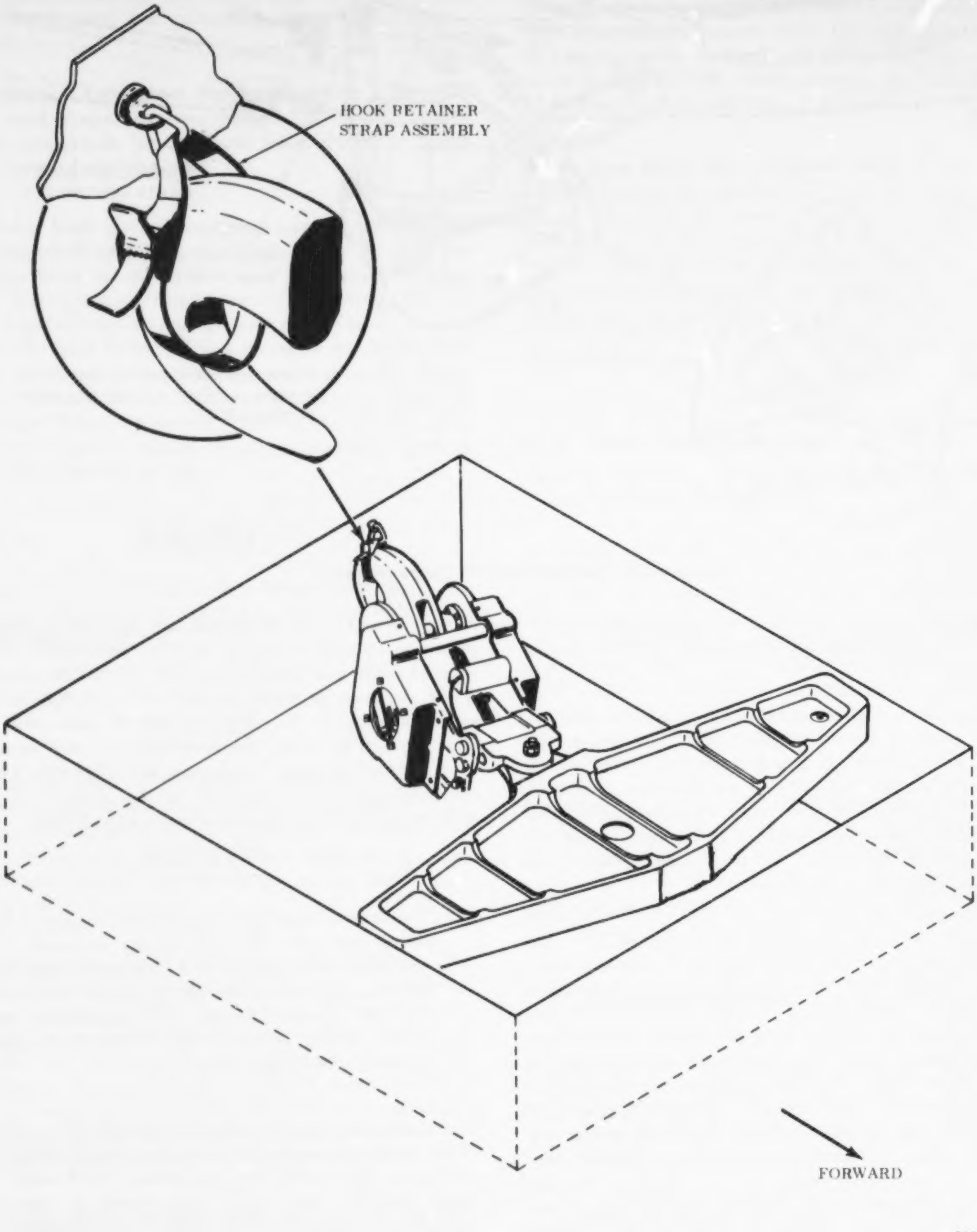
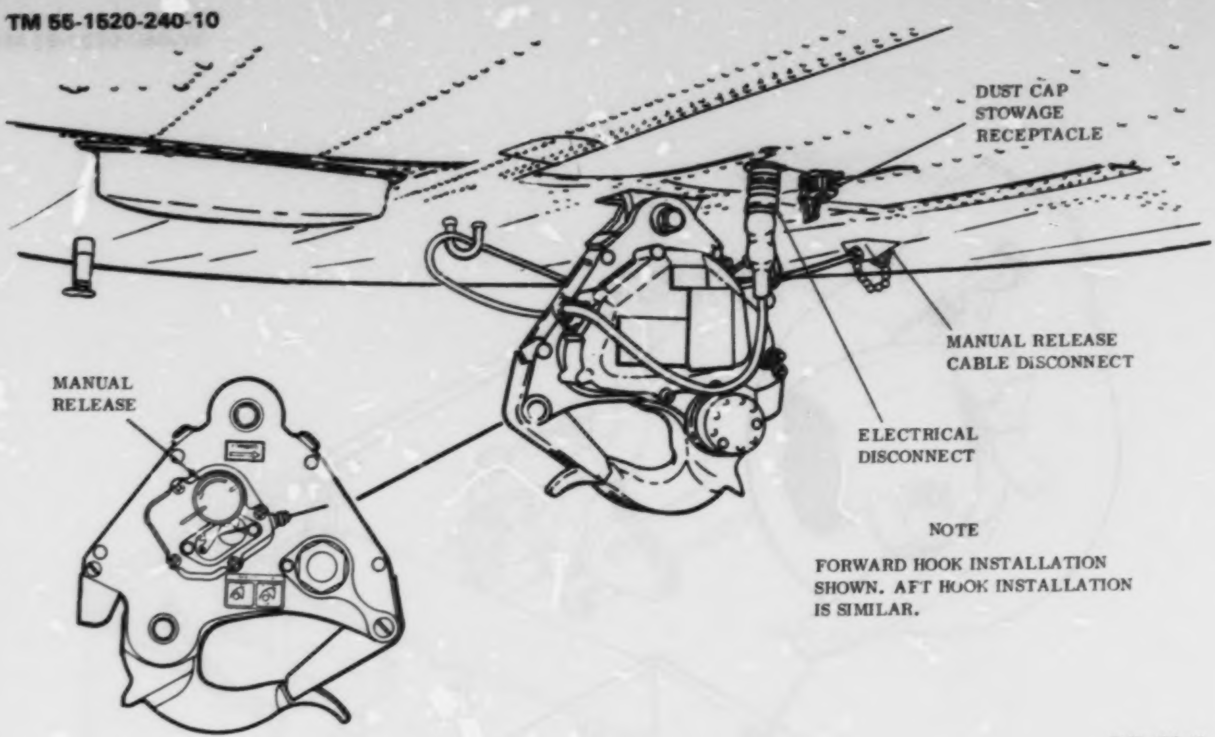

HOOK RETAINER STRAP ASSEMBLY
FORWARD
D145-121-10

Figure 4-31. Center Cargo Hook Stowage



NOTE

FORWARD HOOK INSTALLATION SHOWN. AFT HOOK INSTALLATION IS SIMILAR.

Figure 4-32. Forward and Aft Cargo Hooks

OFF position is used to close the mid cargo hook. RESET position is used to turn off the HOOK OPEN caution lights.

b. Cargo hook select switch. The CARGO HOOK SELECT switch is on the CARGO HOOK panel on the overhead switch panel. It is a five position rotary switch marked HOOK SELECT. The switch positions are FWD, MID, AFT, TANDEM, and ALL. The position of this switch determines which hook or hooks open when the CARGO HOOK RELEASE switch on either control stick or the hoist operators grip is pressed.

c. Cargo hook arming switch. A CARGO HOOK ARM switch is on the hoist operator's panel (fig. 4-27) in the cargo compartment. The hoist operator's control panel CARGO HOOK ARM switch has three marked positions: ARM, RMTE (remote), and RESET. When the cockpit CARGO HOOK MASTER switch is at ARM, and the hoist operator's switch is moved to ARM, power is applied to the CARGO HOOK RELEASE switch, on the winch/hoist control grip. When the switch is at RMTE, power is removed from the CARGO HOOK RELEASE switch and the cargo hooks can be operated from the cockpit only. RESET position is used when the pilot requests that the center cargo hook be closed from the hoist operator's station. When the switch is set to RESET, the CARGO HOOK OPEN caution lights will go out.

d. Cargo hook release switches. A CARGO HOOK RELEASE switch is on each of the following: the pilot's control stick grip (fig. 2-23), the copilot's control stick grip and the winch/hoist control grip (fig. 4-26). Any one of these switches can be used to operate the cargo hooks. Each of these switches are the momentary type. When either the pilot's or copilot's CARGO HOOK RELEASE switch is pressed with the CARGO HOOK MASTER switch at ARM, the hook or hooks selected on the HOOK SELECT switch will open. The forward and aft hooks will open, then close. The center hook, if selected, will open and remain open until the cargo hook MASTER switch on the overhead panel is set to OFF or the cargo hook ARM switch on the hoist operators panel is set to RESET.

CAUTION

The forward and aft hooks may fail to open if the slings are slack when the release solenoids are energized (a load of 18 to 22 pounds is required for opening). The hooks can be opened by selecting the desired hook(s) and depressing the release switch as the aircraft is lifted to apply tension to the slings.

e. Emergency cargo hook release switch. The emergency cargo hook release switch is on the CARGO HOOK control panel (fig. 4-22). It is a guarded switch and it is labeled EMERG REL ALL. The switch is used to simultaneously open the three hooks, if an emergency situation develops. The three hooks will open regardless of CARGO HOOK MASTER or HOOK SELECT switch positions. Setting the switch to REL ALL, energizes an emergency hook release relay. The relays then energizes release solenoids in the forward and aft hooks and a solenoid valve in the center hook. The solenoid valve in the center hook releases the aircharge stored in the lower half of the hydraulic actuator, transferring the charge to the upper (release) half of the actuator to open the hook. After this method of opening the hook, the hook actuator must be recharged to 2,100 psi. The emergency hook release relay will automatically deenergize after a 10 second time delay. This prevents damage to the hook release solenoids.

4-54. Manual Emergency Release Systems. The triple cargo hook system has two manual emergency release systems: one system for the center hook, the other system for the forward and aft hooks.

a. Center hook manual emergency release handle (fig. 4-30). A manually operated cargo hook release handle is on the cargo hook assembly. It is used to release the hook should failure in the utility hydraulic or electrical systems occur. A spring-tensioned cargo hook release lever controls a camshaft which keeps the hook locked in the closed position. A metal cable connects the lever arm to the release handle which is held in place on the support beam by metal clips. When the handle is pulled upward, the lever moves the camshaft enough to allow the cargo hook to swing free, releasing the load.

WARNING

When the center cargo hook is opened with the external load off the ground, the cargo hook will whip back and forth.

CAUTION

When the center cargo hook is opened using the manual emergency release handle, the hook must be closed manually. No attempt should be made to close the hook using the normal hydraulic or pneumatic method, since damage to the cargo hook can result.

b. Forward and aft hook emergency release handle. The manual release handle for the forward and aft hooks is in the rescue hatch (fig. 4-30). The handle is connected by cables to the manual release mechanisms in the forward and aft hooks. The handle has three positions: vertical, forward, and aft. The vertical position is the normal position when external cargo is carried on the forward or aft hook. The handle is pulled aft to open the hooks and release the cargo. The forward position is the stowed position.

4-55. Cargo Hook Caution Lights. The cargo hook caution lights are on the master caution panel (fig. 2-46). They are labeled FWD HOOK OPEN, MID HOOK OPEN, and AFT HOOK OPEN. A lit caution light indicates that the corresponding hook has opened. The lights can be extinguished by setting the CARGO HOOK MASTER switch to RESET or by setting the CARGO HOOK switch on the hoist operators panel to RESET.

4-56. Hook Loaded Advisory Lights. Two advisory lights marked HOOK LOADED are on the CARGO HOOK control panel (fig. 4-22). The lights are marked HOOK LOADED. When on, the light indicates that the corresponding (forward or aft) hook has a load of above approximately 150 pounds on it. The lights are turned on by sensors in the forward and aft hooks. Regardless of cargo hook MASTER switch position, the lights come on when hook load exceeds about 150 pounds.

4-57. Dual Hook Fault Caution Lights. A caution light labeled DUAL HOOK FAULT is on the master caution panel. This light provides continuous monitoring of the electrical continuity of the release solenoids in the forward and aft hook. When on, it indicates a loss of electrical release capability of the forward and/or aft hook in both normal and emergency modes. When the light is on, loads on the forward or aft hooks can only be released by the manual release system.

4-58. Cargo Hooks Operational Check.

Prior to external load operations, perform the following check of the cargo hooks.

1. CARGO HOOK MASTER switch — ARM.

2. CARGO HOOK SELECT switch — FWD.

3. Press the CARGO HOOK RELEASE switch on the pilot's cyclic control stick — Check that the FWD HOOK OPEN caution light comes on and the hook opens.

NOTE

The forward and aft hooks will not open unless a force is applied. As long as one of the CARGO HOOK RELEASE switches are pressed, the forward and aft hooks will make a sound like a machine gun firing. This sound indicates the hooks are operating normally.

4. CARGO HOOK SELECT switch — MID.

5. Press the CARGO HOOK RELEASE switch on the copilot's cyclic control stick. Check that the MID HOOK OPEN caution light comes on and the hook opens.

6. CARGO HOOK SELECT switch — AFT.

7. CARGO HOOK switch on HOIST OPERATORS PANEL — ARM (Flight Engineer).

8. Press the CARGO HOOK RELEASE switch on the WINCH/HOIST CONTROL GRIP (Flight Engineer). Check that the AFT HOOK OPEN caution light comes on and the hook opens. RESET and release to OFF.

9. CARGO HOOK MASTER switch — RESET and release to OFF. Check all HOOK OPEN caution lights go out and the hooks close. Then set ARM.

10. CARGO HOOK SELECT switch — TANDEM.

11. Press the CARGO HOOK RELEASE switch on the pilot's cyclic control stick. Check that the FWD and AFT HOOK OPEN caution lights come on and the forward and aft hooks open.

12. CARGO HOOK MASTER switch — RESET and release to OFF. Check both HOOK OPEN caution lights go out and the hooks close.. Then set ARM.

13. CARGO HOOK SELECT switch — ALL.

14. Press the CARGO HOOK RELEASE switch on the copilot's cyclic control stick. Check that all HOOK OPEN caution lights come on and the hooks open.

15. CARGO HOOK MASTER switch — RESET and release to OFF. Check all HOOK OPEN caution lights go out and the hooks close.

16. To confirm safety of the cargo hook system, the pilot, copilot, and flight engineer each press a CARGO HOOK RELEASE switch to attempt to open cargo hooks with the CARGO HOOK MASTER switch at OFF.

4-59. Normal Operation of Cargo Hooks.

Normal operation of the cargo hooks from the cockpit or from the cargo compartment is as follows:

1. CARGO HOOK MASTER switch — ARM. (If used from the cockpit or the cargo compartment.)

2. HOIST OPERATORS PANEL CARGO HOOK switch — ARM. (If used from the cargo compartment.)

3. HOOK SELECT switch — Rotate to hook or hooks to be released.

4. CARGO HOOK RELEASE switch — Press. (From either the cockpit or the cargo compartment.) Do not hold cargo hook release switch continuously.

5. Master caution panel — Check HOOK OPEN caution light comes on.

6. Loads — Check released. If the forward or aft hooks did not open because of sling slack, press the release switch and lift the helicopters to apply a strain to the sling and pull the hooks open.

4-60. Emergency Operation of Cargo Hooks.

Emergency operation of the cargo hook is accomplished from the cockpit or cabin. Refer to para 9-96.

4-61. Helicopter Internal Cargo Handling System (HICHS).

An internal cargo handling system is provided for quick loading and unloading of palletized cargo (fig. 4-33). The system consists of a set of rail assemblies and guide roller assemblies that are secured to the aircraft floor and allow rapid loading, securing and unloading of cargo pallets.

The system has 3 main sections: a cabin section, a ramp section, and a ramp extension section (fig. 4-35). The cabin section has outboard rail/rollers along both sides of the cabin near the aircraft walls, and inboard guide rollers running along the center of the cabin. There are six outboard rail/roller assemblies, three on each side of the cabin. Each of the six rail/roller assemblies has its own dedicated location in the aircraft. The left and right side rail/roller assemblies are symmetrically opposite. There are four inboard guide roller assemblies mounted in the center of the cabin. All of the outboard and inboard roller assemblies are installed by being bolted to existing tiedown fitting locations in the cabin floor.

The system is equipped with a set of locking devices and tiedown fittings for securing loaded cargo.

NOTE

> **All cargo must be properly restrained to ensure safe operation of the helicopter and the safety of personnel. Loads must be restrained in accordance with procedures and guidelines in FM 55-450-2, Helicopter Internal Loads.**

The ramp section has two inboard roller assemblies along the center of the ramp and two outboard guide rail/roller assemblies along the sides of the ramp. A ramp support assembly is used to support the ramp when loading or unloading the aircraft with the ramp in the horizontal position.

The Ramp Extension Section has two ramp extension roller assemblies and two ramp extension support assemblies to support the ramp extensions when loading and unloading with the ramp in the horizontal position.

4-62. HICHS Cargo Types.

The HICHS allows relatively quick and easy loading of palletized cargo. The following pallet types may be used:

a. Three 463 L pallets, 88 X 108 inches.

b. Six HCU-12/E or HCU-10/C pallets, 54 X 88 inches.

c. Eight to ten warehouse wooden pallets, 40 X 48 inches.

The HICHS has provisions for locking and securing 463 L pallets. This type of pallet does not need to be tied down but the cargo must be secured to the pallet. Combinations of different pallet types may be used. Miscellaneous cargo and equipment may be carried providing that they do not exceed weight or floor loading restrictions, and can be properly tied down. (Chap. 6.)

4-63. System Configurations.

The Internal Cargo Handling System can be placed in any of one of four configurations. These are loading, restraint, flight, and unloading. Refer to Chapter 6 for configurations applicable to 463L pallets, warehouse pallets, and wheeled vehicles.

To accomplish the configurations described above and in the referenced tables, several components

must be set in a predetermined position. These components are listed below in conjunction with the illustration that defines the component location and/or position.

a. Outboard rollers — Fig. 4-34.
b. Warehouse pallet guides — Fig. 4-34.
c. Ramp support assy — Fig. 4-34.
d. Pallet lock assy — Fig. 4-35.
e. Retractable flange assy — Fig. 4-33.
f. 10K fitting assy — Fig. 4-36.
g. 5K fitting assy — Fig. 4-36.

4-64. Hatch Access.

Remove, if necessary, any cargo forward of Sta 377.250 to at least Sta 157.750.

Remove three centerline ring plug assemblies to free the forward hatch inboard guide roller assembly (fig. 4-35). Stow the removed parts ahead of Sta 272.250. The hatch is now accessible and the removed parts can be re-installed by reversing the preceding steps.

4-65. System Stowage.

Flip up the outboard rail/roller assemblies and secure to the seat support tube as shown in fig. 4-34. Secure loading pole to clips located at the top of the buffer board between Sta 300 and 400 on right side of aircraft with quick release pin. Inboard guide roller assemblies can be stowed on the floor beneath the troop seats. Secure ramp extension rollers to the underside of the ramp extensions with quick release pins. Stow ramp extension supports on wl 0.00 beam between Sta 520 and 534 on left side of aircraft. Stow ramp support on wl 0.00 beam at sta 550 on left side of aircraft.

4-66. Load Configuration and Sequence.

Chapter 6 contains the detailed descriptions and procedures for load configuration and sequence.

4-67. Extended Range Fuel System (ERFS).

The helicopter is provisioned to accept the extended range fuel system when using the HICHS 463L pallets.

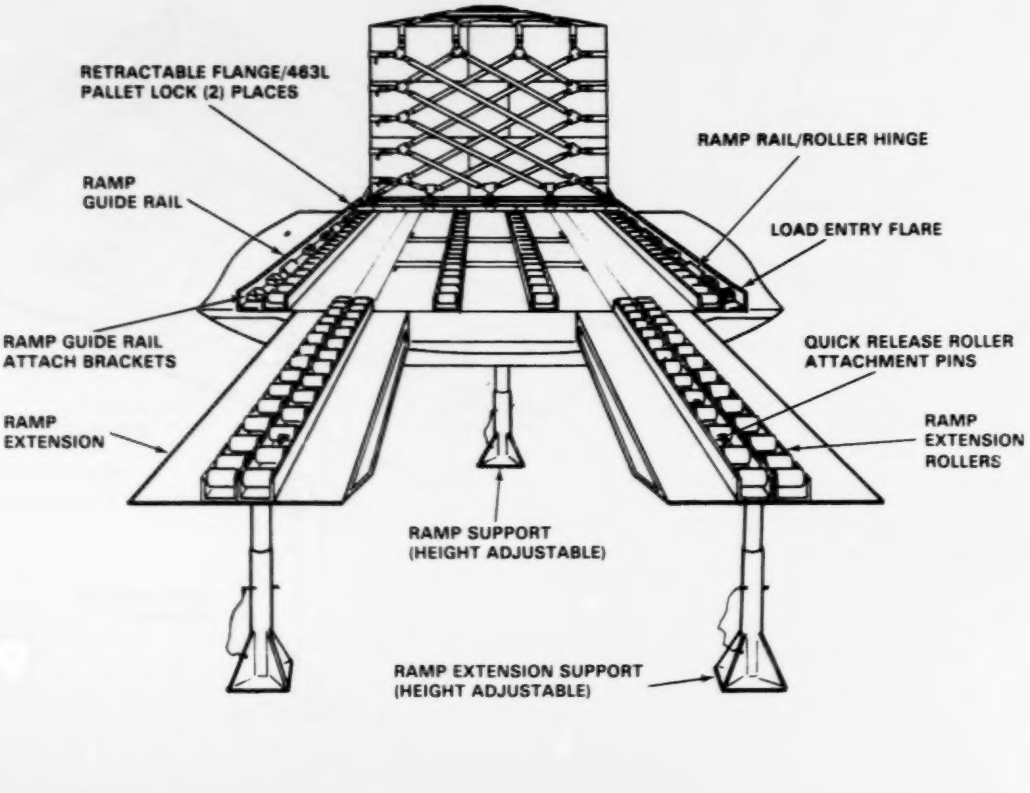
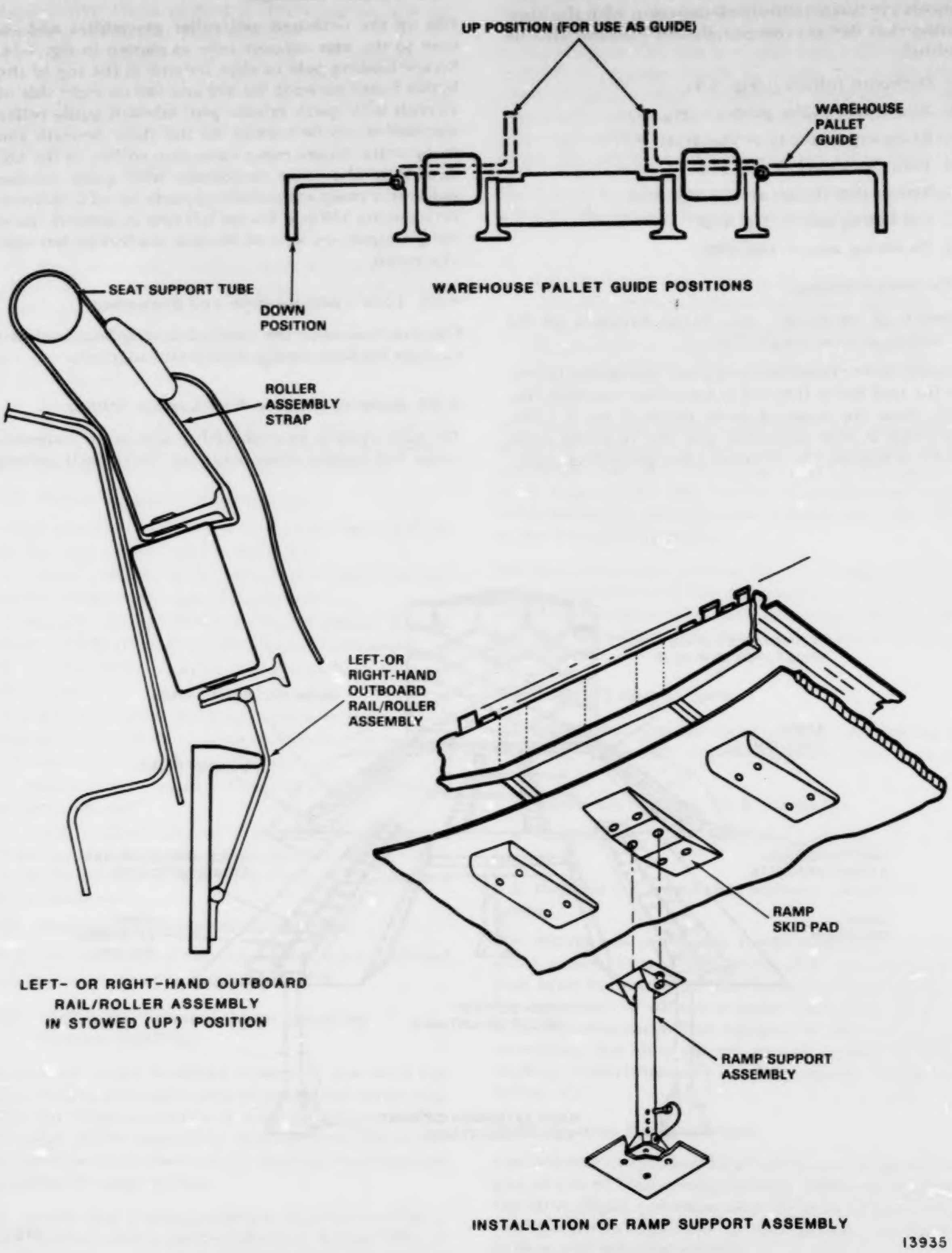

RETRACTABLE FLANGE/463L PALLET LOCK (2) PLACES
RAMP RAIL/ROLLER HINGE
RAMP GUIDE RAIL
LOAD ENTRY FLARE
RAMP GUIDE RAIL ATTACH BRACKETS
QUICK RELEASE ROLLER ATTACHMENT PINS
RAMP EXTENSION
RAMP EXTENSION ROLLERS
RAMP SUPPORT (HEIGHT ADJUSTABLE)
RAMP EXTENSION SUPPORT (HEIGHT ADJUSTABLE)
13934

Figure 4-33. HICHS with 463L Palletized


UP POSITION (FOR USE AS GUIDE)
WAREHOUSE PALLET GUIDE
DOWN POSITION
SEAT SUPPORT TUBE
ROLLER ASSEMBLY STRAP
LEFT-OR RIGHT-HAND OUTBOARD RAIL/ROLLER ASSEMBLY
RAMP SKID PAD
RAMP SUPPORT ASSEMBLY
13935

WAREHOUSE PALLET GUIDE POSITIONS

LEFT- OR RIGHT-HAND OUTBOARD RAIL/ROLLER ASSEMBLY IN STOWED (UP) POSITION

INSTALLATION OF RAMP SUPPORT ASSEMBLY

Figure 4-34. Fixture Configuration

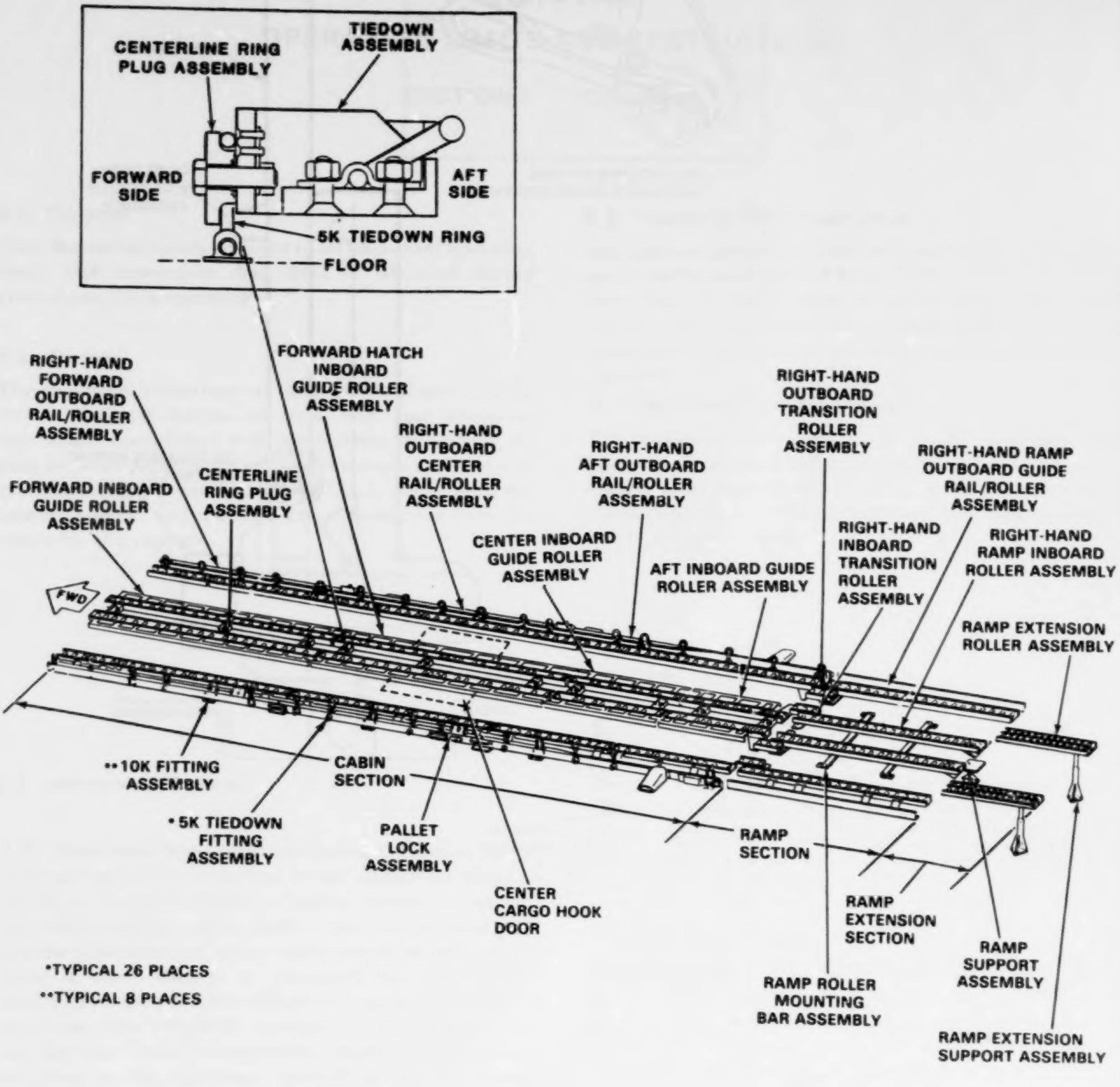

TIEDOWN ASSEMBLY
CENTERLINE RING PLUG ASSEMBLY
FORWARD SIDE
AFT SIDE
5K TIEDOWN RING
FLOOR
RIGHT-HAND FORWARD OUTBOARD RAIL/ROLLER ASSEMBLY
FORWARD HATCH INBOARD GUIDE ROLLER ASSEMBLY
RIGHT-HAND OUTBOARD TRANSITION ROLLER ASSEMBLY
RIGHT-HAND OUTBOARD CENTER RAIL/ROLLER ASSEMBLY
RIGHT-HAND AFT OUTBOARD RAIL/ROLLER ASSEMBLY
RIGHT-HAND RAMP OUTBOARD GUIDE RAIL/ROLLER ASSEMBLY
FORWARD INBOARD GUIDE ROLLER ASSEMBLY
CENTERLINE RING PLUG ASSEMBLY
CENTER INBOARD GUIDE ROLLER ASSEMBLY
RIGHT-HAND INBOARD TRANSITION ROLLER ASSEMBLY
RIGHT-HAND RAMP INBOARD ROLLER ASSEMBLY
AFT INBOARD GUIDE ROLLER ASSEMBLY
FWD
RAMP EXTENSION ROLLER ASSEMBLY
**10K FITTING ASSEMBLY
CABIN SECTION
*5K TIEDOWN FITTING ASSEMBLY
PALLET LOCK ASSEMBLY
RAMP SECTION
CENTER CARGO HOOK DOOR
RAMP EXTENSION SECTION
RAMP SUPPORT ASSEMBLY
RAMP ROLLER MOUNTING BAR ASSEMBLY
RAMP EXTENSION SUPPORT ASSEMBLY
*TYPICAL 26 PLACES
**TYPICAL 8 PLACES
13936

Figure 4-35. Internal Cargo Handling System

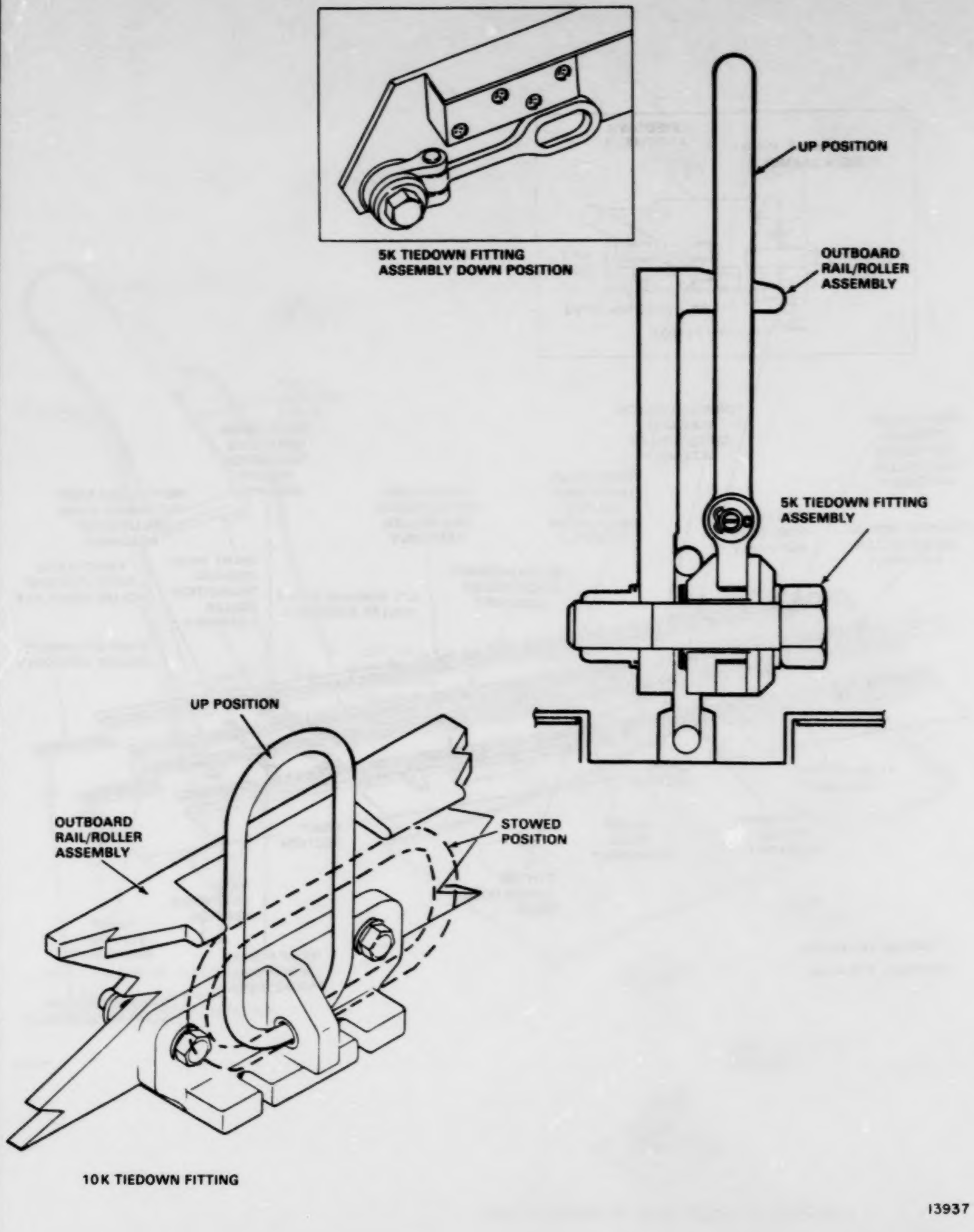

5K TIEDOWN FITTING ASSEMBLY DOWN POSITION
UP POSITION
OUTBOARD RAIL/ROLLER ASSEMBLY
5K TIEDOWN FITTING ASSEMBLY
UP POSITION
OUTBOARD RAIL/ROLLER ASSEMBLY
STOWED POSITION
10 K TIEDOWN FITTING
13937

Figure 4-36. Tiedown Fittings HICHS

CHAPTER 5
OPERATING LIMITS AND RESTRICTIONS

SECTION I GENERAL

5-1. Purpose.

This chapter identifies or refers to all important operating limits and restrictions that shall be observed during ground and flight operations.

5-2. General.

The operating limitations set forth in this chapter are the direct result of design analysis, test, and operating experience. Compliance with these limits will allow the pilot to safely perform the assigned missions and to derive maximum utility from the aircraft. Limits concerning maneuvers, weight, and center of gravity limitations are also covered in this chapter.

5-3. Exceeding Operational Limits.

Any time an operational limit is exceeded, an appropriate entry shall be made on DA Form 2408-13. Entry shall state what limit or limits were exceeded, range, time above limits, and any additional data that would aid maintenance personnel in maintenance action that may be required.

5-4. Minimum Crew Requirement.

The minimum crew required to fly this helicopter is a pilot, copilot, and flight engineer. Additional crewmembers, as required, will be added at the discretion of the commander, in accordance with pertinent Department of the Army Regulations.

SECTION II SYSTEM LIMITS

5-5. Instrument Markings.

5-6. Instrument Marking Color Codes. Operating limitations and ranges are identified by the colored markings on the dials of engine, flight and utility system instruments. The RED markings on the dials of these instruments indicate the limit above or below which continued operation is likely to cause damage or shortened life. The GREEN markings on instruments indicate safe or normal range of operation. The YELLOW markings on instruments indicate the time limited range when special attention should be given to the operation covered by the instrument. Operation is permissible in the yellow range, but should be avoided. BLUE is a maximum indication associated with sustained operation of the related aircraft system for a prescribed period of time. Limitations (fig. 5-1) which are marked on the various instruments are not necessarily repeated in the subsequent text. When further explanation of certain markings is required, refer to the specific area of discussion.

5-7. Instrument Glass Alinement. All instruments with range markings on the glass have short white alinement marks extending from the dial glass onto the rim of the indicator. These slippage marks appear as a single line when limitation markings on the glass properly aline with the proper increments on the dial face. However, the slippage marks appear as separate radial lines when a dial glass has rotated.

5-8. Rotor Limitations.

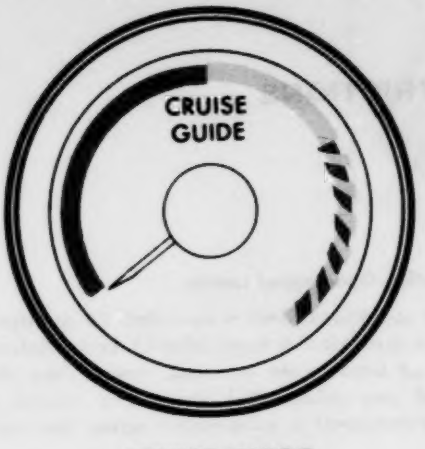
Refer to figure 5-1 for limitations. Should 108 percent power off be inadvertently exceeded, no entry need be made in DA Form 2408-13 unless the rotor system accelerates to 115 percent or above. Even though no action is required when rotor rpm exceeds 108 percent power off but remains less than 115 percent, willful operation should not be conducted in this range. Operation between 96 and 92 percent (MIN BEEP) is permitted when water taxiing.

5-9. Starting and Shutdown Limits.

Engine starting should not be attempted if surface wind speeds, including gusts, are above 30 knots. Shutdown with winds in excess of 30 knots shall be made with the helicopter facing into the wind. The apu shall not be started with a tail wind in excess of 25 knots. Main engines shall not be started with a tailwind in excess of 10 knots.

□
■
■

ENGINE LIMITATIONS BASED ON USE OF JP-4 FUEL

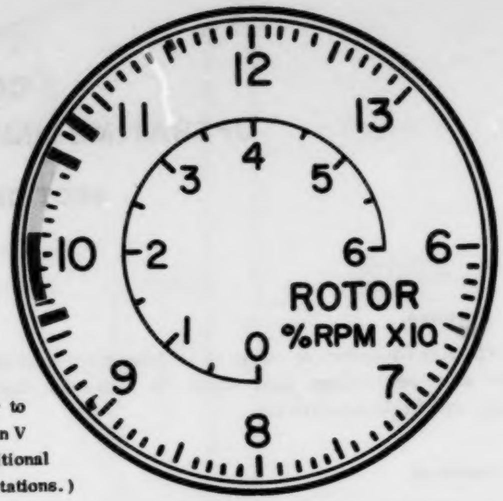

CRUISE GUIDE

CRUISE GUIDE INDICATOR

(Refer to Section V for Additional Information)

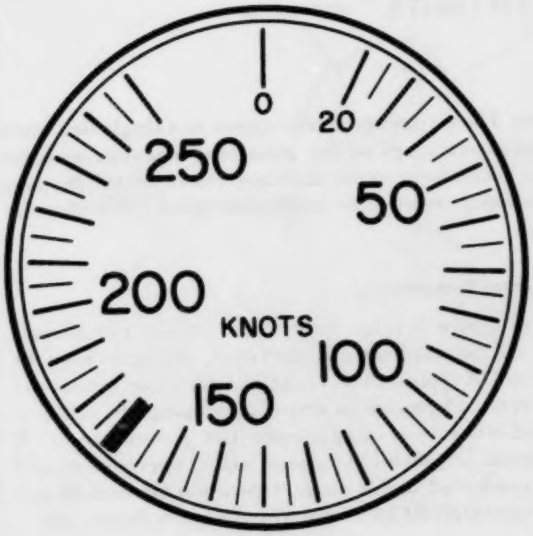
■ Normal Operation
□ Transient
▨ Avoid

(Refer to Section V for Additional Rotor Limitations.)


12
13
11
4
3
5
10
2
6
6
ROTOR
%RPM X10
1
0
9
7
8

ROTOR TACHOMETER

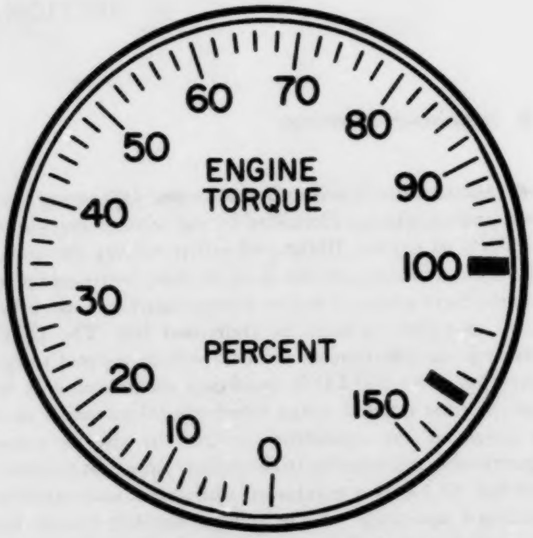
■ 91 Percent Minimum Transient
■ 96 Percent Minimum For Ground Operation
■ 97 To 101 Percent Normal Operation
□ 102 To 105 Percent Transient
■ 106 Percent Maximum Transient Power On
■ 108 Percent Maximum During Autorotation
■ 115 Percent Maximum Transient


0
20
250
50
200
KNOTS
100
150

AIRSPEED

■ 170 Knots Maximum

(Refer to Section V for Additional Airspeed Limitations.)


60
70
80
50
ENGINE
TORQUE
90
40
100
30
PERCENT
20
150
10
0

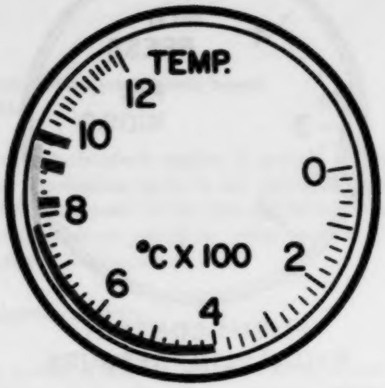
TORQUEMETER

■ 100 Percent Maximum Dual Engine
■ 123 Percent Maximum Single Engine

Y □
R ■
G ■

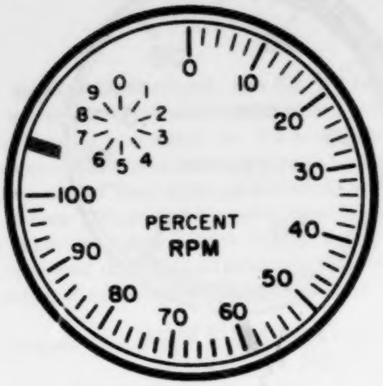
D145-66-10①

Figure 5-1. Instrument Markings (Sheet 1 of 3)


TEMP.
12
10
8
6
4
2
0
°C X 100

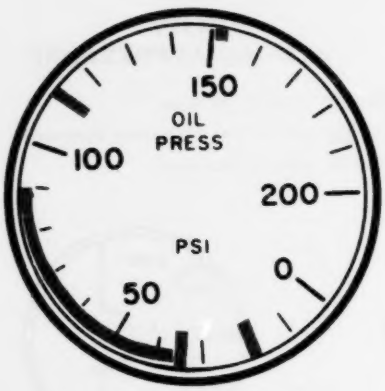
POWER TURBINE INLET TEMPERATURE

▬ 400°C To 780°C Continuous Operation
▬ 810°C Maximum For Not More Than 30 Minutes
▬ 890°C Maximum For Not More Than 10 Minutes
▬ 781°C To 940°C Time-Limited Operation
▬ 940°C Maximum, For Not More Than 12 Seconds Never Exceed
☞ 890°C to 930°C Emergency Power (Single Engine Operation)


0
10
20
30
40
50
60
70
80
90
100
0 1 2 3 4 5 6 7 8 9
PERCENT
RPM

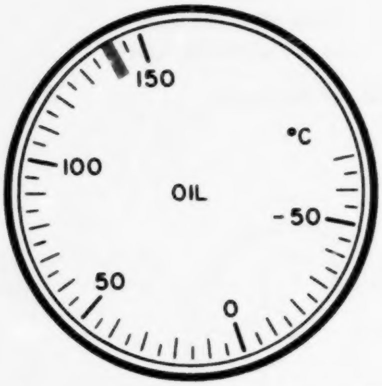
GAS PRODUCER TACHOMETER

▬ 60 Percent Minimum Ground Idle.
▬ 107 Percent Maximum (Single Engine) And Transient


150
OIL
PRESS
100
200
PSI
50
0

ENGINE OIL PRESSURE

▬ 20 Psi Minimum At Ground Idle
▬ 35 Psi Minimum At 80 To 94% N1
50 Psi Minimum At 95% N1 Or Above
▬ 35 To 90 Psi For Normal Operation
▬ 110 Psi Maximum At Emergency Power
▮ 150 Psi Maximum For Cold Weather Starts


150
°C
100
OIL
-50
50
0

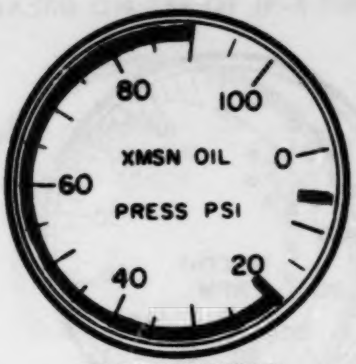
ENGINE OIL TEMPERATURE

▬ 140°C Maximum

R 🟥
Y ☐
G 🟩
B ⬛

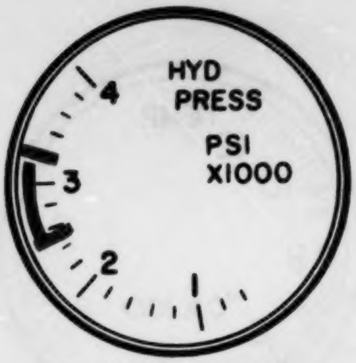
10516

Figure 5-1. Instrument Markings (Sheet 2 of 3)


80
100
XMSN OIL
0
60
PRESS PSI
40
20

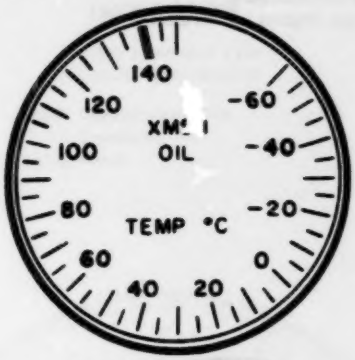
TRANSMISSION OIL PRESSURE

▬ 7 PSI Minimum at Ground Idle
▬ 20 PSI Minimum
▬ 20 to 90 PSI Normal Operation


HYD
PRESS
4
PSI
X1000
3
2
1

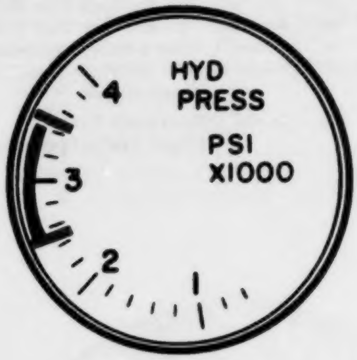
FLIGHT CONTROL HYDRAULIC PRESSURE

▬ 2500 PSI Minimum
▬ 2500 to 3200 PSI Normal Operation
▬ 3200 PSI Maximum


140
120
-60
XMSN
100
OIL
-40
80
-20
TEMP °C
60
0
40
20

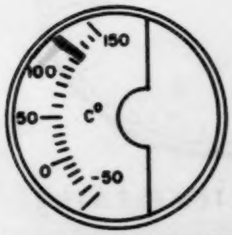
TRANSMISSION OIL TEMPERATURE

▬ 140°C Maximum


4
HYD
PRESS
PSI
X1000
3
2
1

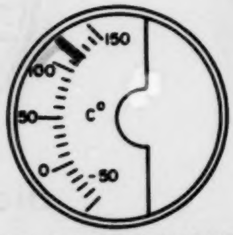
UTILITY HYDRAULIC PRESSURE

▬ 2500 PSI Minimum
▬ 2500 to 3500 PSI Normal Operation
▬ 3500 PSI Maximum


150
100
50
C°
0
-50

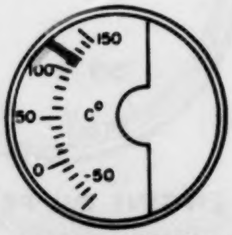
NO. 1 FLIGHT CONTROL HYDRAULIC TEMPERATURE

▬ 120°C Maximum
▭ 95°C to 120°C Caution


150
100
50
C°
0
-50

NO. 2 FLIGHT CONTROL HYDRAULIC TEMPERATURE

▬ 120°C Maximum
▭ 95°C to 120°C Caution


150
100
50
C°
0
-50

UTILITY HYDRAULIC TEMPERATURE

▬ 120°C Maximum
▭ 95°C to 120°C Caution

Figure 5-1. Instrument Markings (Sheet 3 of 3)

SECTION III POWER LIMITS

5-10. Engine Rating and Power Level Limits.

Operation of a turboshaft engine is greatly affected by atmospheric conditions such as air pressure and temperature. For variations in torque available with temperature and pressure altitude, refer to the Torque Available charts in Chapter 7.

5-11. Emergency Power.

Emergency power is only to be used during actual emergency conditions. After 30 minutes of emergency power time have accumulated, the engine must be inspected. The black and white emergency power indicator flag shall be reset upon landing. Total time shall be entered on the DA FORM 2408-13.

5-12. Engine Limitations. **See fig. 5-1 for limitations. A gas producer (N1) overspeed exists when an N1 of 107 percent is exceeded. An N1 overspeed can cause overtemperature and/or overtorque. A power turbine (N2) overspeed may exist, depending on power being used, when 106 percent rotor rpm is exceeded. An entry must be made on DA FORM 2408-13 indicating peak rpm and duration so maintenance personnel can determine if an overspeed has occurred.**

5-13. Engine Temperature Limitations. See fig. 5-1.

5-14. Fuel Limitations. Only those fuels listed in Chapter 2 shall be used.

5-15. Transmission Torque Limitations (Steady-State). See fig. 5-1 for limitations.

Figure 5-2. Deleted.

SECTION IV LOADING LIMITS

5-16. Center-of-Gravity Limitations.

See fig. 6-30 for center-of-gravity limits in terms of gross weight and fuselage stations.

5-17. Maximum Gross Weight.

The maximum allowable operating gross weight is 50,000 pounds.

5-18. Cargo Hook Limitations. The limits presented below are structural limitations only.

a. The structural limit of the forward and aft hook is 17,000 pounds each.

b. The maximum single load that can be suspended as a tandem load from the forward and aft hooks is 25,000 pounds.

c. The center cargo hook is limited to a maximum load of 26,000 pounds.

5-19. Rescue Hoist Limitations. The rescue hoist is limited to a maximum load of 600 pounds.

SECTION V AIRSPEED LIMITS

5-20. Airspeed Operating Limits.

a. Airspeed limitations with an operative cruise guide indicator are per the following indicator displays (not to exceed 170 KIAS):

(1) Needle must be kept in green band.

(2) Transient needle excursions into the yellow band are permissible but should be minimized.

(3) Needle excursions into the red/yellow band are to be avoided.

b. Airspeed limitations with an inoperative cruise guide indicator are per the airspeed limitations shown in Fig. 5-5.

(1) Flight at or below 98% rotor rpm with an inoperative cruise guide indicator is prohibited.

c. The following airspeed limitations apply with an operative or inoperative cruise guide indicator:

(1) Maximum airspeed in sideward flight is 45 knots.

(2) Maximum airspeed in rearward flight is 45 knots.

(3) Maximum crosswind or tailwind for hover is 45 knots.

(4) Maximum airspeed with the lower section of the cabin entrance door open and locked is 60 KIAS.

(5) The rescue hatch door shall not be opened or closed above 90 KIAS. Otherwise the limitations specified in a. and b. above apply.

d. Maximum airspeed with Mil-Van type load is dependent on load weight and rigging procedure. If a sling or hook should fail while carrying a tandem load, limit airspeed to a maximum of 60 KIAS.

(1) Tandem rigging. (Figure 5-3.)

(a) Maximum airspeed for Mil-Van weight up to 7000 pounds is 70 KIAS.

(b) Maximum airspeed for Mil-Van weight from 7000 pounds to maximum load is 110 KIAS.

(2) Tandem rigging with forward redundant sling. (Figure 5-4.)

(a) Maximum airspeed for Mil-Van weight up to 7000 pounds is 100 KIAS.

(b) Maximum airspeed for Mil-Van weight from 7000 pounds to maximum load is at Vh.

(3) When carrying large external loads, such as the Mil-Van, maximum airspeed for sideward and rearward flight is 20 knots.

(4) Maximum airspeed with high density cargo (jeep, gamma goat, M114, M198) is dependent on load weight and rigging procedure.

(a) Tandem rigging:

1. Maximum speed for weights up to 7000 pounds is 120 KIAS.

2. Maximum speed for weights from 7000 pounds to maximum weight is Vh.

(b) Tandem rigging with forward redundant rigging or both forward and aft redundant rigging: Maximum airspeed is Vh for all weights up to maximum authorized.

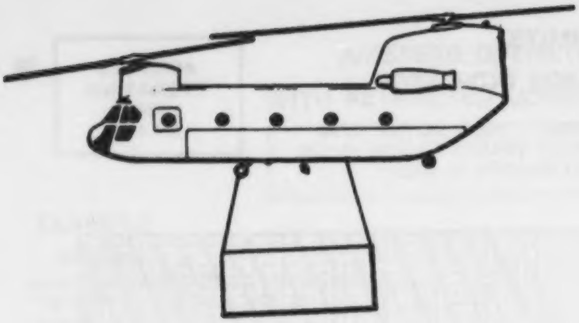


Figure 5-3. Tandem Hook Rigging Without Redundant Sling

e. The windshield wipers should be shut off at airspeeds above 130 knots.

5-21. Cyclic Trim Actuator Airspeed Limits. Use Fig. 5-6 to find the maximum airspeed with either cyclic trim actuator failed at the fully retracted position. Do not manually extend the longitudinal cyclic trim beyond the GND position on the cyclic trim indicators at indicated airspeeds below 60 knots. Use of extended cyclic trim at low airspeeds will result in high aft rotor blade stresses.

5-22. AFCS Limitations.

The airspeed limit when operating on single AFCS is 100 KIAS or Vne, whichever is slower. The helicopter may be operated with both AFCS off up to 160 KIAS or Vne, whichever is slower, provided both AFCS are disabled below 100 KIAS.

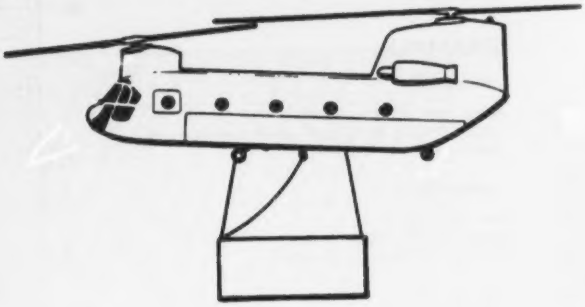


Figure 5-4. Tandem Hook Rigging With Forward Hook Redundant Sling

G ■

AIRSPEED OPERATING LIMITS WITH INOPERATIVE CRUISE GUIDE INDICATOR

PROGRAMMED LONGITUDINAL CYCLIC TRIM 100% ROTOR RPM

AIRSPEED OPERATING LIMITS CH-47D

EXAMPLE

WANTED

MAX INDICATED AIRSPEED FOR GIVEN TEMP, PRESS ALTITUDE, AND GROSS WEIGHT

KNOWN

FAT = -30°C
PRESS ALTITUDE = 8,600 FT
GROSS WEIGHT = 38,000 LB

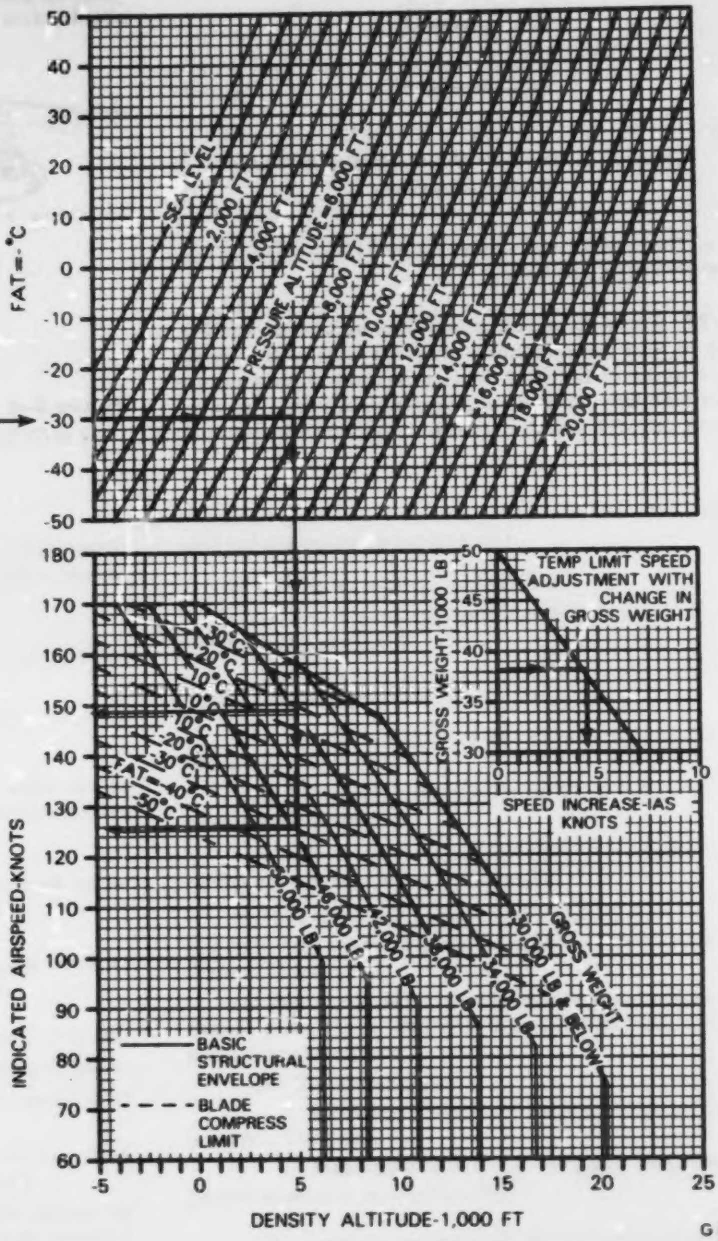
METHOD

ENTER FAT AT = -30°C
MOVE RIGHT TO
PRESS ALTITUDE = 8,600 FT
- MOVE DOWN TO GROSS WEIGHT LINE (38,000 LB), MOVE LEFT AND READ IAS = 148 KT
- MOVE DOWN TO TEMP LINE (-30°C) MOVE LEFT AND READ IAS = 125 KT

USE INSERT GRAPH TO ADJUST TEMP LIMIT SPEED FOR CHANGE IN GROSS WEIGHT.
ENTER AT GW = 38,000 LB MOVE RIGHT, THEN DOWN TO READ INCREMENTAL SPEED INCREASE = 4.3 KT (IAS).
NOW, IAS = 125 + 4 = 129 KT AT GROSS WEIGHT = 38,000 LB.

USE LOWER VALUE AS MAXIMUM IAS.

MAX IAS = 129 KT



G ■

Figure 5-5. Airspeed Limitations — Inoperative Cruise Guide Indicator

AIRSPEED OPERATING LIMITS WITH RETRACTED LONGITUDINAL CYCLIC TRIM

AIRSPEED OPERATING LIMITS CH-47D

NOTE: USE OF CRUISE GUIDE INDICATOR TO EXCEED THESE IS PROHIBITED

EXAMPLE

WANTED

MAX INDICATED AIRSPEED FOR GIVEN TEMP, PRESS ALTITUDE, AND GROSS WEIGHT

KNOWN

FAT = 20°C
PRESS ALTITUDE = 2,000 FT
GROSS WEIGHT = 42,000 LB

METHOD

ENTER FAT AT 20°C, MOVE RIGHT TO PRESS ALTITUDE = 2,000 FT
MOVE DOWN TO GROSS WEIGHT LINE (42,000 LB), MOVE LEFT AND READ IAS = 74 KT

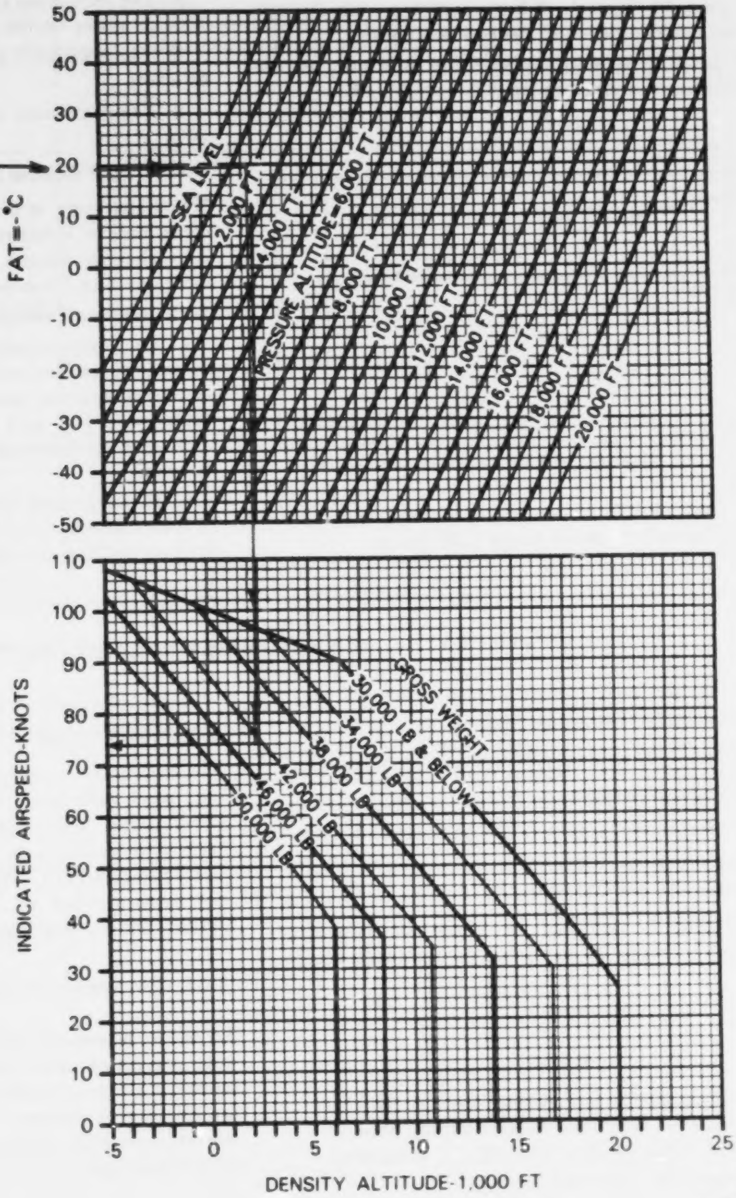


Figure 5-6. Airspeed Limitations — Longitudinal Cyclic Trim Retracted

SECTION VI MANEUVERING LIMITS

5-23. Aerobatics Prohibition.

Aerobatics are prohibited with this helicopter.

5-24. Bank Limitations.

The following bank angle limits apply:

a. With an operative cruise guide indicator, bank angles are as limited by the cruise guide indicator, but no greater than 60 degrees. When operating with altitude hold, limit bank angles to 45 degrees maximum.

b. With an inoperative cruise guide indicator, use the bank angle limits defined by fig. 5-7.

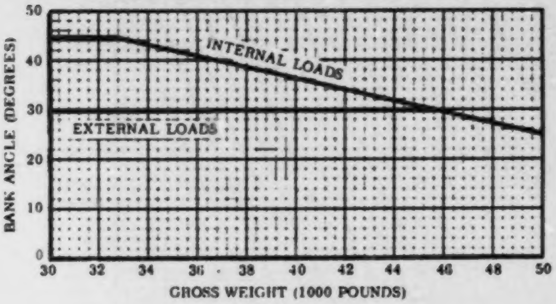


Figure 5-7. Bank Angle Limitations

5-25. Landing Limitations.

a. The maximum rate of descent at touchdown for gross weights up to 33,000 pounds is 492 feet per minute.

b. The maximum rate of descent at touchdown for gross weights from 33,000 to 40,000 pounds is 450 feet per minute.

c. The maximum rate of descent at touchdown for gross weights above 40,000 pounds is 360 feet per minute.

d. The maximum ground speed for running landings is 60 knots.

e. The maximum nose-up attitude during landings is 20°.

5-26. Flight Control Limitations.

When operating at or above an airspeed of 100 knots, the thrust control is not to be lowered at a rate which exceeds 2.5 inches per second. There is no limiting rate for movement less than 2.0 inches.

5-27. Ground Taxiing Limitations

a. To prevent droop stop pounding while taxiing, flight control movements are not to exceed 0.75 inch right or left for the directional pedals, 2 inches longitudinally aft of neutral and 1.00 inch laterally right or left for the cyclic stick, and not below the ground detent for the thrust control rod.

b. When ground taxiing in congested areas or within 75 feet of an obstruction, a blade watcher and taxi director shall be positioned as shown in figure 8-4.

SECTION VII ENVIRONMENTAL RESTRICTIONS

5-28. Engine Inlet Screen Limitation.

Refer to table 5-1 for information on bypass panel removal.

5-29. Altitude Limitations.

Refer to cruise charts in Chapter 7.

5-30. Flight Under IMC (Instrument Meteorological Conditions).

This helicopter is qualified for flight in instrument meteorological conditions provided the following conditions exist.

a. Both AFCS are operational.

NOTE

> Should one AFCS fail during IMC flight the flight may be continued to destination. Should both AFCS fail during IMC flight, a landing should be made as soon as practical.

b. Two vertical gyros and two vertical gyro indicators (VGI) are installed and operative.

5-31. Flight In Ice.

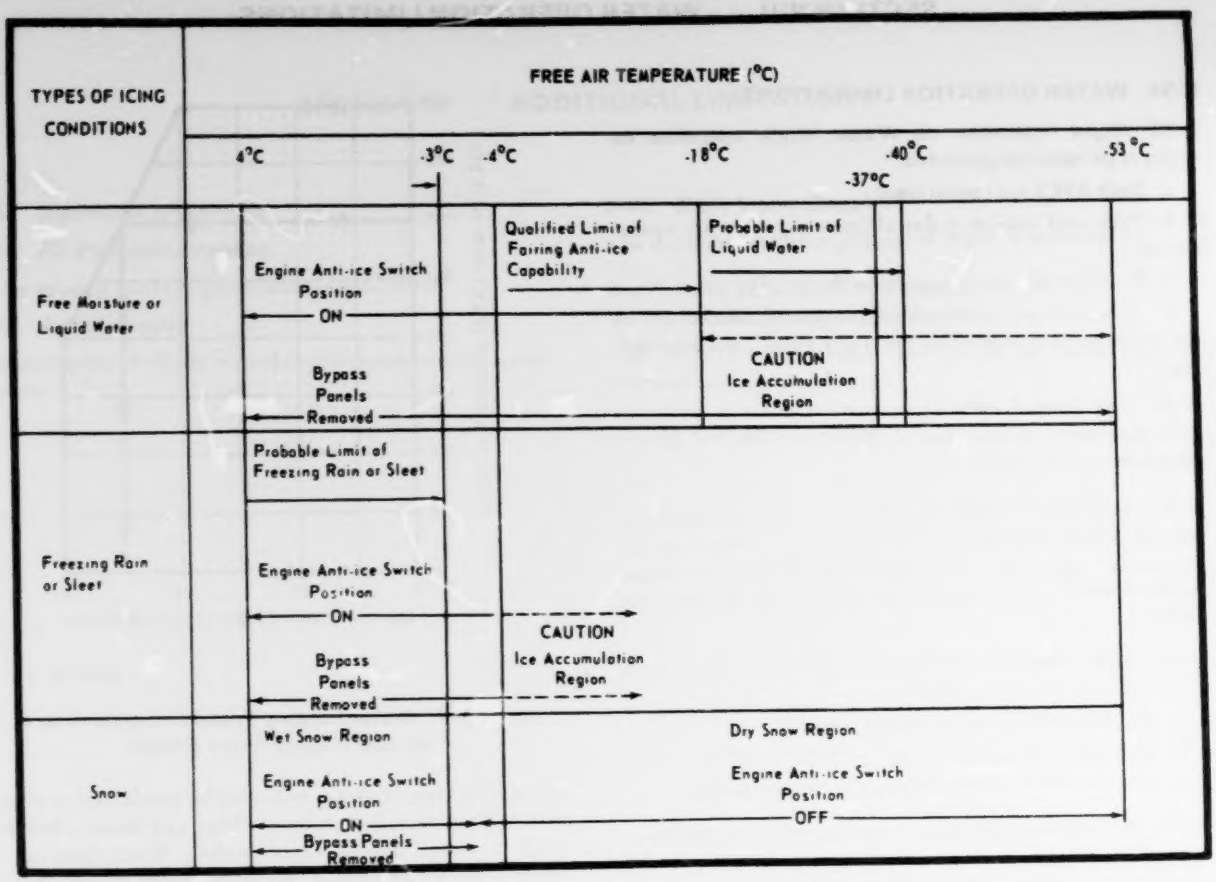
The helicopter is equipped with adequate engine anti-icing, pitot tube and Advanced Flight Control Systems (AFCS) yaw port heating, and windshield anti-icing system to enable safe flight in light icing conditions. Continuous flight in light icing conditions below 5°C is not recommended since blade damage can occur from asymmetric ice shedding.

5-32. Thunderstorm Operation.

To ensure adequate lightning strike protection, the lightning protection cables and straps must be installed and intact on all rotor blades. If any lightning cables or straps are missing or broken, avoid flight in or near thunderstorms, especially in areas of observed or anticipated lightning discharges.

5-33. Operation With Skis. If skis are installed, the following limits apply.

Table 5-1. Engine Anti-Ice and Bypass Panel Removal Requirement


TYPES OF ICING CONDITIONS
FREE AIR TEMPERATURE (°C)
4°C
-3°C
-4°C
-18°C
-40°C
-37°C
-53°C
Free Moisture or Liquid Water
Engine Anti-ice Switch Position
ON
Qualified Limit of Fairing Anti-ice Capability
Probable Limit of Liquid Water
CAUTION
Ice Accumulation Region
Bypass Panels Removed
Freezing Rain or Sleet
Probable Limit of Freezing Rain or Sleet
Engine Anti-ice Switch Position
ON
CAUTION
Ice Accumulation Region
Bypass Panels Removed
Snow
Wet Snow Region
Engine Anti-ice Switch Position
ON
Bypass Panels Removed
Dry Snow Region
Engine Anti-ice Switch Position
OFF

a. The maximum allowable airspeed is limited to 130 knots indicated airspeed or vne, whichever is lower, regardless of gross weight.

b. The maximum allowable gross weight for ground operation is 50,000 pounds.

c. The maximum allowable rate of descent at touchdown in snow is 480 feet per minute at gross weights up to 33,000 pounds, decreasing linearly to 240 feet per minute at 46,000 pounds gross weight. For gross weights 46,000 pounds to 50,000 pounds, the rate of descent is 240 feet per minute.

d. The maximum taxi speed is 5 knots when operating on hard prepared surfaces.

SECTION VIII WATER OPERATION LIMITATIONS

5-34. WATER OPERATION LIMITATIONS.

5-35. Night Operation on Water. Night operation on water is permissible provided:

a. Both AFCS are operational.

b. Pilot and copilot radar altimeter systems are operational.

c. A visible horizon is present at the landing site.

d. Two or more highly visible, stationary objects are on the water surface to provide necessary visual cues for landing.

5-36. Sea State Limits. Operation on water is restricted to a maximum of Sea State 2. Refer to table 5-2 for information on sea states.

5-37. Operation Time Limit. Operation on water is restricted to 30-minutes total flotation time without draining the helicopter. The helicopter must be drained following each water operation and an entry made on DA Form 2408-13.

5-38. Gross Weight Limitations. Maximum gross weight for water operations is as follows:

a. Normal operations — 36,000 pounds.

b. Emergency rescue missions — 46,000 pounds.

c. Aircraft emergency (ditching) — 50,000 pounds.

5-39. Taxiing Limitations. Taxiing will not be conducted in water conditions above Sea State 1 or in wind above 6 knots. Fast taxiing will be conducted in a straight line only and in a maximum speed of 10 knots when the lower nose enclosure is left in the water. Taxiing can be conducted up to 15 knots provided the lower plexiglass nose enclosure is kept out of the water.

5-40. Landing Limitations. Water landings can be performed within the limitations presented on fig. 5-8. The touchdown speeds presented do not reflect indicated airspeed. Running landings will only be conducted onto calm water. The ramp, lower rescue door, and main cabin door shall be closed during water landing. Water landings are prohibited when fuel in the main tanks is less than 50 percent.

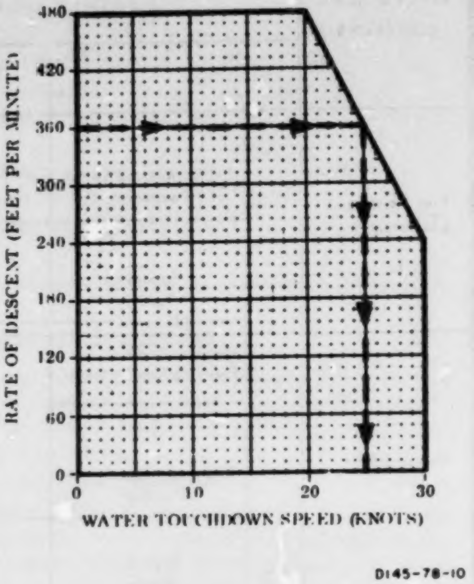


Figure 5-8. Water Landing Speed Limitations up to 46,000 Pounds Gross Weight

5-41. Rotor Starting and Shutdown Limitations. Rotor starting or shutdown will not be conducted when water conditions exceed Sea State 1 or wind exceeds 6 knots. Maximum gross weight for starting and shutdown is 28,550 pounds.

5-42. Autorotative Landings. Practice autorotations to the water are prohibited.

Table 5-2. Description of Sea States

SEA STATE	SEA DESCRIPTION	WIND DESCRIPTION	WIND VELOCITY (KNOTS)	AVERAGE WAVE HEIGHT (FT)
	Sea like a mirror (calm)	Calm	Less than 1	0.0
0	Ripples with appearance of scales; no foam crests (smooth)	Light Air	1-3	0.05
1	Small wavelets; crests of glassy appearance, not breaking (slight)	Light Breeze	4-6	0.2
2	Large wavelets; crests begin to break; scattered whitecaps	Gentle Breeze	7-10	0.6
3	Small waves, becoming longer, numerous whitecaps (moderate)	Moderate Breeze	11-16	1.4

SECTION IX ADDITIONAL LIMITATIONS

5-43. Additional Limitations.

5-44. Air-To-Ground Towing.

Air-to-ground towing operations are prohibited.

5-45. Apu Operation.

Apu operation in flight is prohibited except during emergencies.

5-46. Night Vision Goggles.

The use of night vision goggles at night is authorized.

5-47. Pitot Tube and AFCS Sideslip Port Anti-Icing Limitation.

The PITOT switch shall not be on for more than 5 minutes on the ground.

CHAPTER 6

WEIGHT/BALANCE AND LOADING

SECTION I GENERAL

6-1. Deleted.

6-2. Deleted.

6-3. General. This chapter contains sufficient instructions and data so that the aviator, knowing the basic weight and moment of the helicopter, can compute any combination of weight and balance.

6.3.1. Helicopter Compartment and Loading Diagram. Figure 6-1 defines the compartments, shows the reference datum line, and depicts other information essential for helicopter weight/balance and loading.

6-4. Classification of Helicopter.

Army Model CH-47D helicopters are in Class 2. Additional directives governing weight and balance of Class 2 aircraft forms and records are contained in AR 95-16, TM 55-1500-342-23, and DA PAM 738-751.

SECTION II WEIGHT AND BALANCE

6-5. Deleted.

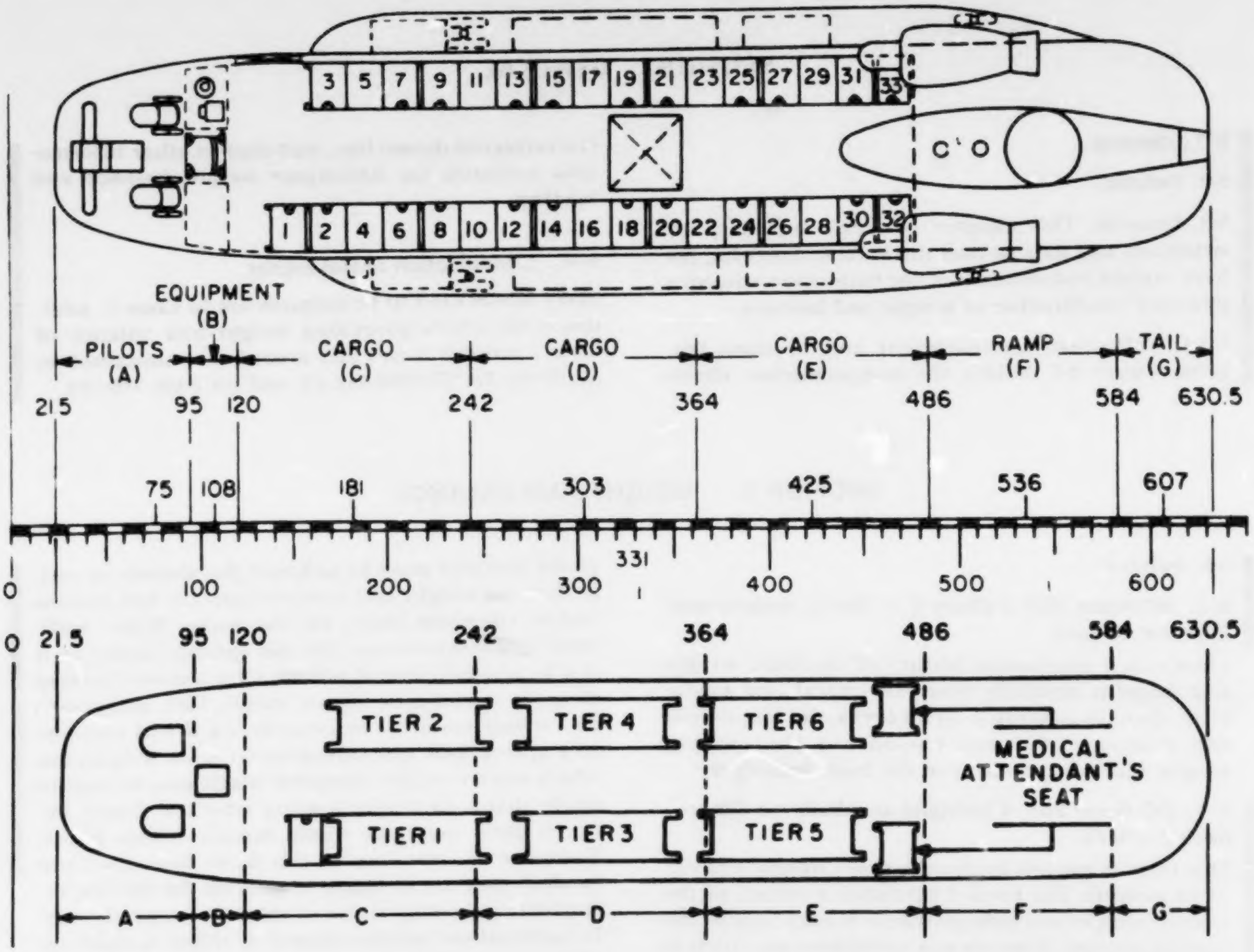
6-6. DD Form 365-3 Chart C — Basic Weight and Balance Record.

Chart C is a continuous history of the basic weight and moment resulting from structural and equipment changes in service. At all times, the last weight and moment/1,000 are considered the current weight and balance status of the basic helicopter.

6-7. DD Form 365-4 (Weight and Balance Clearance Form F).

This form is used to derive the gross weight and c.g. of an aircraft. The Form F furnishes a record of the aircraft weight and balance status at each step of the loading process. It serves as a worksheet on which to record weight and balance calculations and any corrections that must be made to insure that the aircraft will be within weight and c.g. limits. Sufficient completed FORMS F must be onboard the aircraft to verify that the weight and center-of-gravity will remain within allowable limits for the entire flight. Sufficient forms can be one (for the specific flight) or it can be several. Several FORMS F for various loading of crew, passengers; stores, cargo, fuel, slingloads, etc., which result in extreme forward and extreme aft c.g. locations and variations in gross weight, but which remain within allowable limits may be used to verify that a particular loading which is clearly between these extremes would remain within limits. There are two versions of this form: Transport and Tactical; they are designed to provide for the respective loading arrangements of these two type aircraft. The general use and fulfillment of either version are the same. Specific instructions for filling out the form are given in TM 55-1500-342-23.

6-8. Deleted.


3
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7
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11
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15
17
19
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23
25
27
29
31
33
1
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
C'O
EQUIPMENT
(B)
PILOTS
(A)
CARGO
(C)
CARGO
(D)
CARGO
(E)
RAMP
(F)
TAIL
(G)
21.5
95
120
242
364
486
584
630.5
75
108
181
303
425
536
607
0
100
200
300
331
400
500
600
0
21.5
95
120
242
364
486
584
630.5
TIER 2
TIER 4
TIER 6
TIER 1
TIER 3
TIER 5
MEDICAL
ATTENDANT'S
SEAT
A
B
C
D
E
F
G

NOTE:

INCHES FROM REFERENCE DATUM
IDENTICAL TO STATION NUMBERS

Figure 6-1. Aircraft Compartment and Loading Diagram

SECTION III FUEL/OIL

6-9. Fuel and Oil Data.

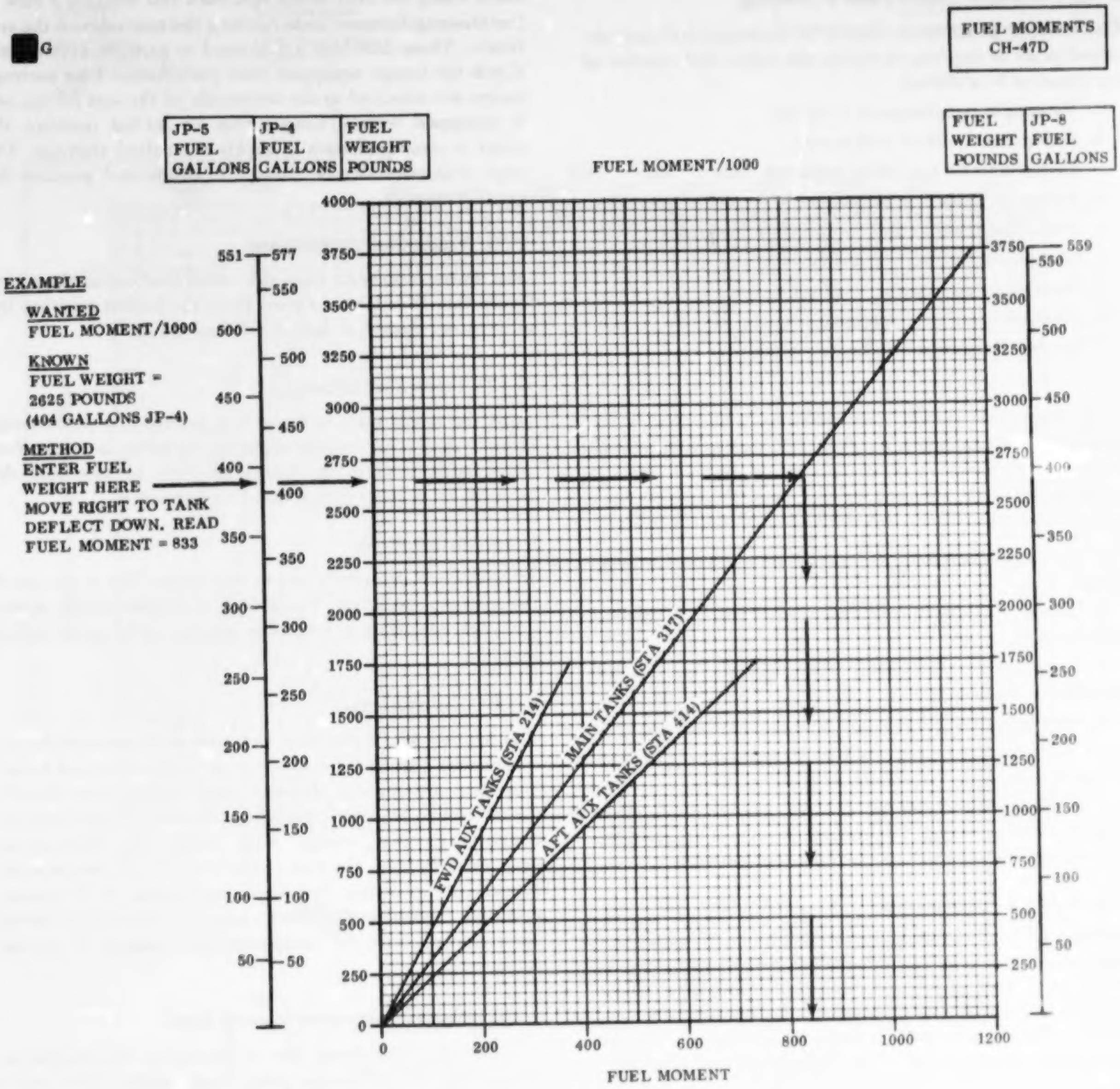
The CH-47D is equipped with six fuel tanks and an integral oil tank on each engine. The capacities of each fuel tank and each engine oil tank are given in table 2-3.

6-10. Fuel Weight and Moment.

Fuel weight and moments for the forward auxiliary, main, and aft auxiliary fuel tanks are shown on figure 6-4. Fuel weight is presented in gallons and pounds based on JP-4 fuel at 6.5 pounds per gallon, JP-5 at 6.8 pounds per gallon, and JP-8 at 6.7 pounds per gallon. To determine the fuel moment for a particular set of tanks, enter the chart at the total fuel weight or gallons in both tanks, proceed right to the applicable tank line, then down to read the fuel moment. See example on figure 6-4. The common auxiliary fuel tank arm is 314.

6-11. Oil Data.

For weight and balance purposes, the weight of engine oil is included in the basic weight.



EXAMPLE

WANTED
FUEL MOMENT/1000

KNOWN
FUEL WEIGHT =
2625 POUNDS
(404 GALLONS JP-4)

METHOD
ENTER FUEL
WEIGHT HERE
MOVE RIGHT TO TANK
DEFLECT DOWN. READ
FUEL MOMENT = 833

D145-125-10

Figure 6-4. Fuel Moment Chart

SECTION IV PERSONNEL

6-12. *Personnel Loading and Unloading.*

The loading procedures should be accomplished and observed prior to loading to ensure the safety and comfort of personnel to be airlifted:

a. Passenger compartment — Clean.
b. Equipment — Stow and secure.
c. Troop seats — Install, as required.
d. Litters — Install, as required.
e. Static line anchor cable — Install, as required.
f. Safety belts — Check, attached.
g. Emergency equipment — Check.
h. Emergency exits — Inspect.
i. Special equipment — Check.

6-13. *Personnel Weight Computation.* When aircraft are operated at critical gross weights, the exact weight of each individual occupant plus equipment should be used. If weighing facilities are not available, or if the tactical situation dictates otherwise, loads shall be computed as follows:

a. Combat equipped soldiers — 240 pounds per individual.

b. Combat equipped paratroopers — 260 pounds per individual.

c. Litter patient (including litter, splints, etc.) — 200 pounds per individual.

d. Medical attendants — 200 pounds per individual.

e. Crew and passengers with no equipment — Compute weight according to each individual's estimate.

f. Refer to figure 6-5 or 6-6 for personnel or litter patient moment data. The chart (figure 6-5) provides precomputed moments for each troop seat position.

6-14. *Seating Arrangement.*

(See figure 6-7.) Seating arrangment for 33 fully equipped ground troops is provided by ten 3-man seats and three 1-man seats. A row of five 3-man seats are installed along each side of the cargo compartment. One-man seats are installed at the forward and aft ends of the left-hand row of seats and one at the aft end of the right-hand row of seats.

6-15. *Troop Seats.*

These seats are made of nylon on tubular aluminum frames and are joined together for greater rigidity and comfort. The seats are joined by means of slide bolt fasteners in the front seat tubes, zipper fasteners on the underside of the seat fabric, and snap fasteners along the vertical edges of the seat-back rests. A slide adjuster below the back rest hanger clips affords adjustment of back rest tension. Seat tension is adjusted by relocating retaining pins in the holes drilled in the front seat tubes. A row of male snap fastener studs along the rear of the seat-back rest matches a row of female snap fastener sockets along the rear edge of the seat fabric. These fasteners are jointed to provide greater seat depth for troops equipped with parachutes. Two stowage straps are attached to the underside of the seat fabric; one is equipped with a hangar clip for folded stowage, the other is equipped with a buckle for rolled stowage. The seats will normally be stowed in the folded position for cargo transport.

6-16. *Troop Seat Installation.*

Install the troop seats from the rolled position as shown in figure 6-8. Install troop seats from the folded position by performing steps 1-4, 6, and 7 of figure 6-8.

6-17. *Troop Seat Stowage.*

Stow the troop seats in the rolled position by performing steps 1 thru 9 in reverse order as set forth in figure 6-8. Stow troop seats in the folded position by reversing the procedures in steps 7, 6, 4, and 1 of figure 6-8.

6-18. *Safety Belts.*

A 2,000-pound-capacity nylon web safety belt is provided for each seat occupant. The belt is adjustable and is equipped with a positive-grip buckle fastener designed for quick release.

6-19. *Troop Loading.*

The loading and unloading of troops will normally be accomplished through the lowered aft cargo door and ramp. The most orderly and efficient troop loading procedure is for the troops to occupy seats from the front to the rear. In unloading, the troops will leave the helicopter progressively from the rear to the front. If the troops to be loaded are carrying full field equipment, it is recommended that the seat-back rests be folded to avoid entanglement with the equipment and damage to the seat back rests.

6-20. *Troop Commander's Jump Seat.*

A collapsible fold-away seat is located in the cockpit entrance for the use of the troop commander. The seat is made of nylon on a tubular aluminum frame.

6-21. *Litter Arrangement.*

(See figure 6-7.) There are provisions for 24 litters, three tiers, four high, along each cargo compartment wall normally occupied by the troop seats. The two 1-man seats in the aft section of the cargo compartment may remain in place to serve as seats for medical attendants. If needed, the 1-man seat in the forward section of the cargo compartment may also remain. It is not necessary to remove the troop seats to install the litters.

PERSONNEL MOMENTS

PERSONNEL MOMENTS
CH-47D

EXAMPLE

WANTED
PERSONNEL MOMENT

KNOWN
PERSONNEL WEIGHT
=240 POUNDS
SEAT POSITION IS
TROOP COMMANDER
SEAT.

METHOD
ENTER WEIGHT
OF EACH SEAT
POSITION HERE.
MOVE RIGHT TO SEAT POSITION.
MOVE DOWN READ
MOMENT=25

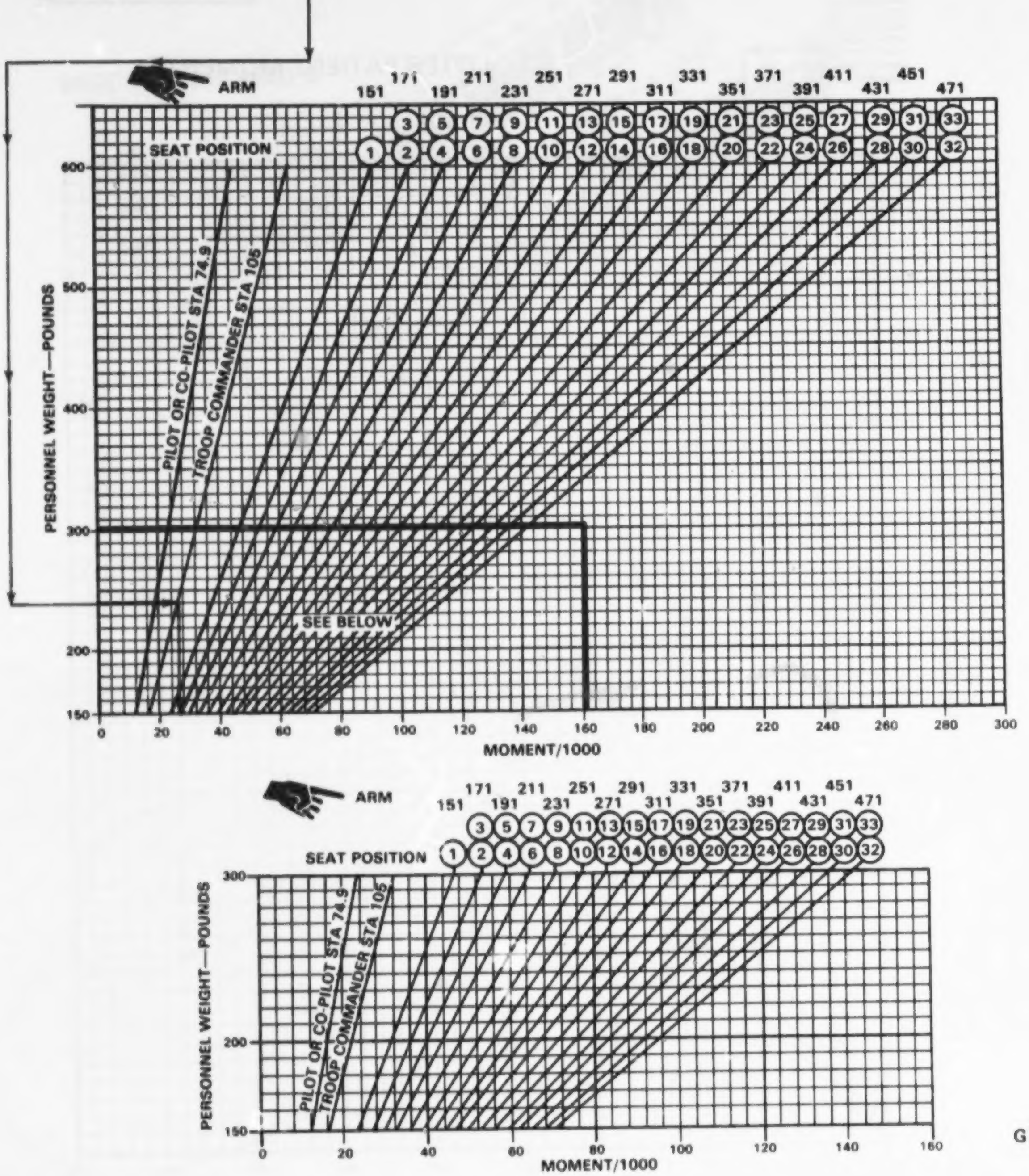


Figure 6-5. Personnel Moments

EXAMPLE

WANTED

PATIENT MOMENT

KNOWN

PATIENT WEIGHT
= 800 POUNDS.
TIER POSITION IS
NUMBER 5.

METHOD

ENTER WEIGHT
OF EACH TIER
POSITION HERE.
MOVE RIGHT TO
TIER POSITION.
MOVE DOWN READ
MOMENT = 326

LITTER PATIENT MOMENTS
CH-47D

LITTER PATIENT MOMENTS

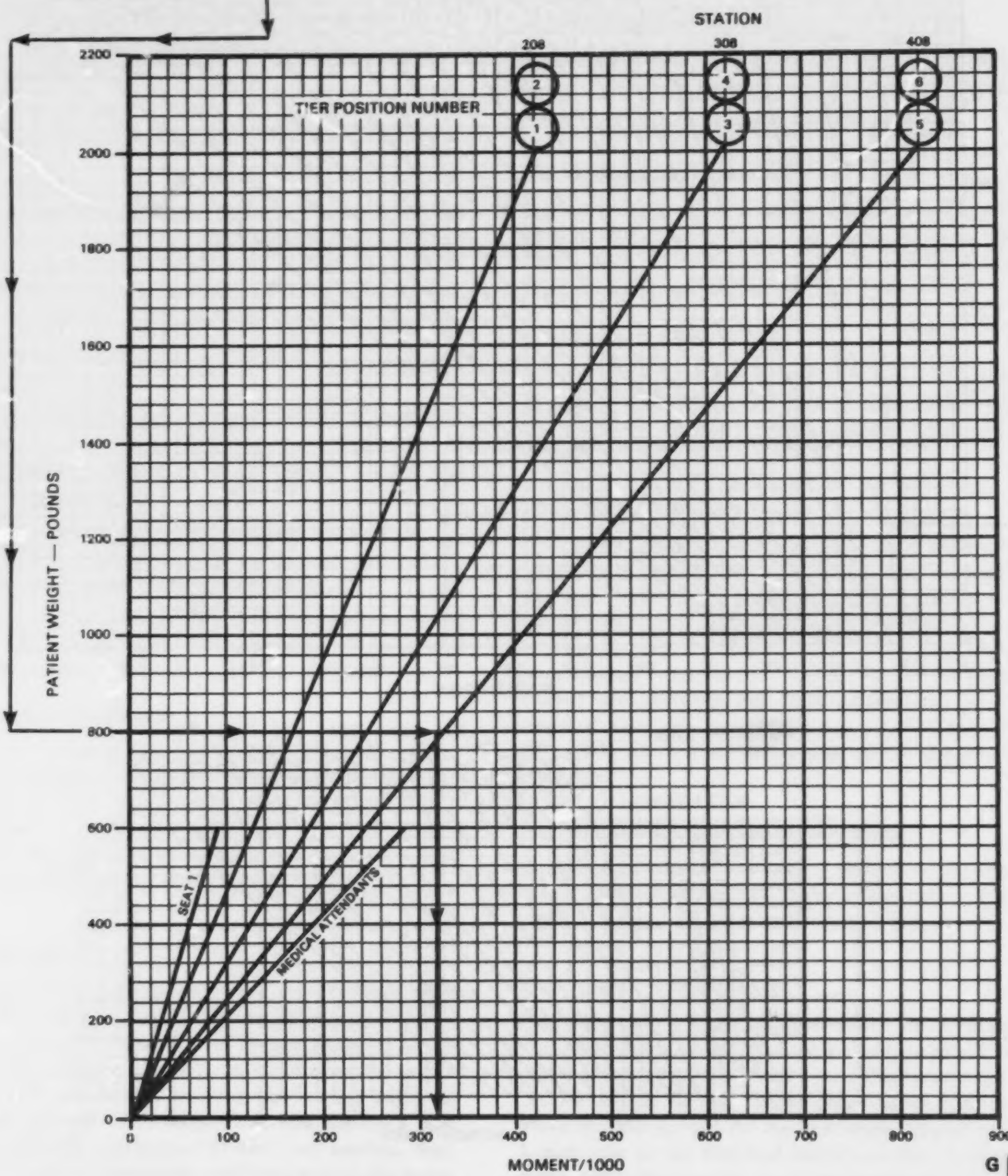


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Figure 6-6. Litter Patient Moments

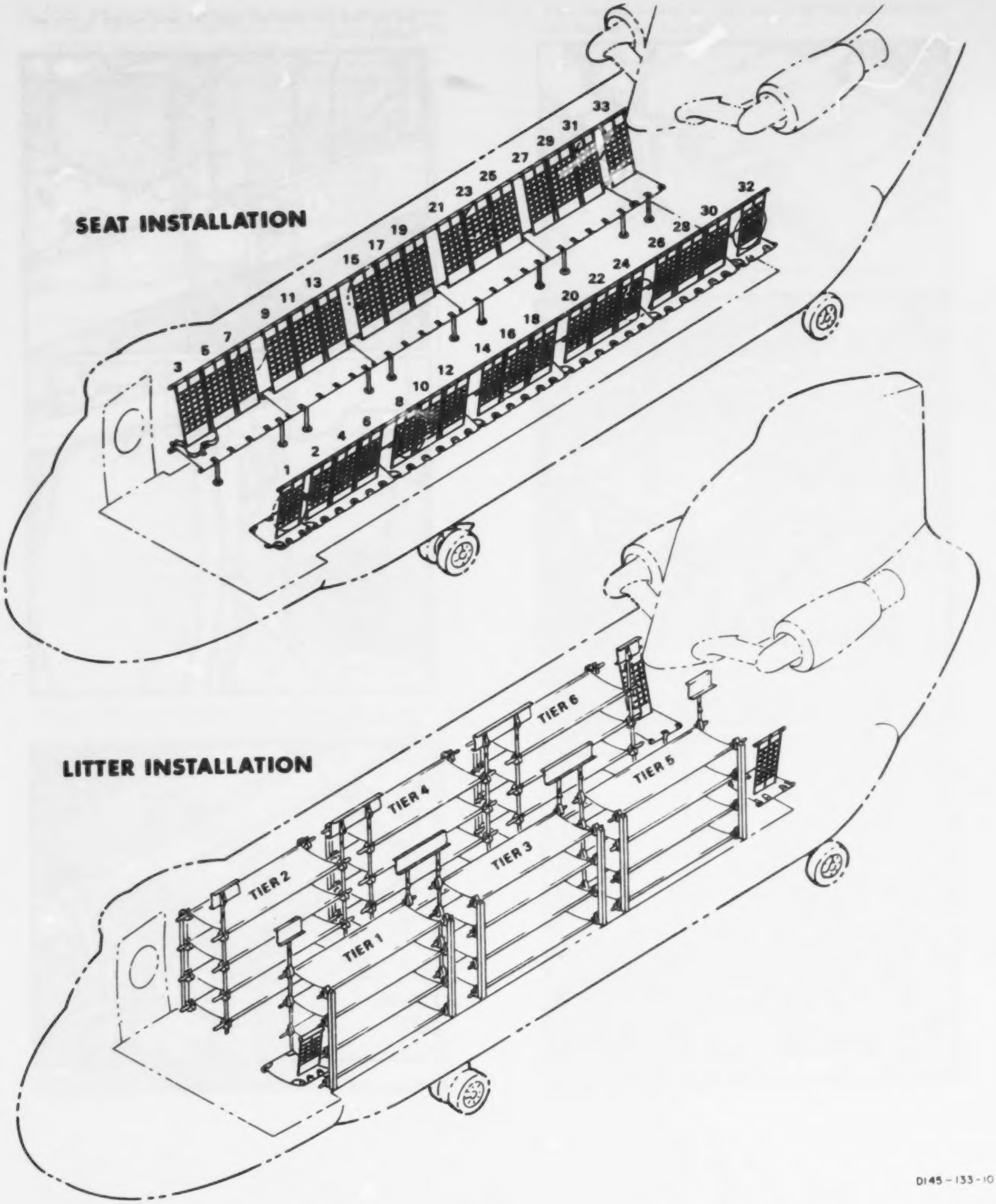
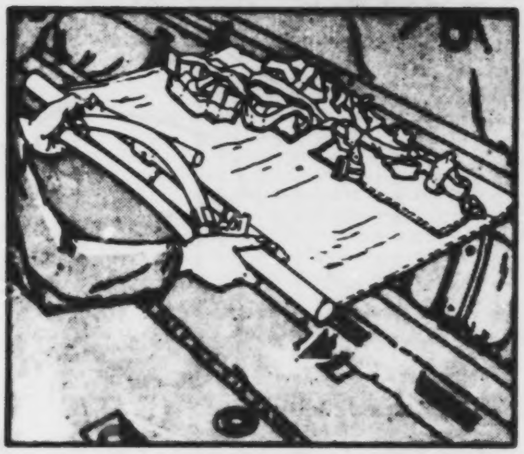
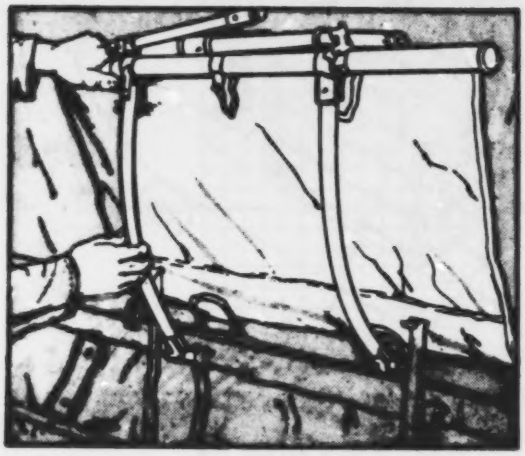

SEAT INSTALLATION
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
LITTER INSTALLATION
TIER 1
TIER 2
TIER 3
TIER 4
TIER 5
TIER 6
D145-133-10

Figure 6-7. Troop Seats and Litters

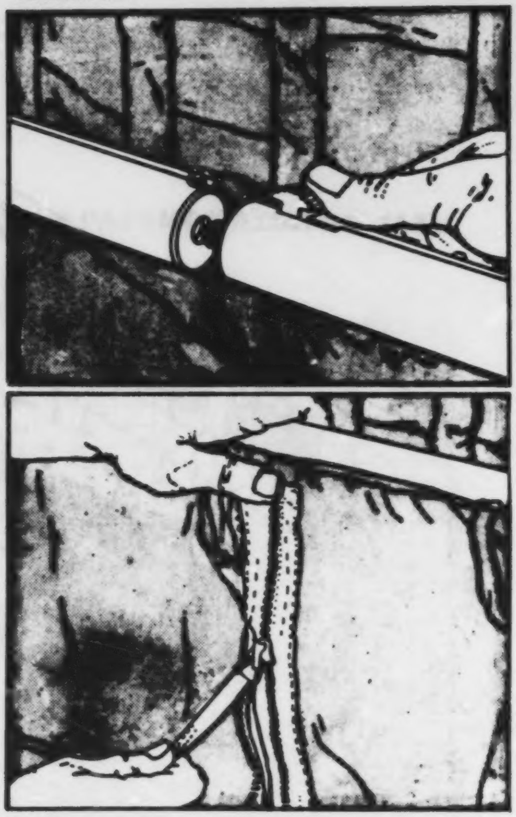
1 Unbuckle, unroll, and extend the seat.



2 Swing the spreader tubes into position, and engage the end of each spreader with the clip on the rear seat tube.



3 Join the front seat tubes and zipper the seats together to form one continuous seat.



4 Swing the seat legs toward the perpendicular position until they lock in this position.

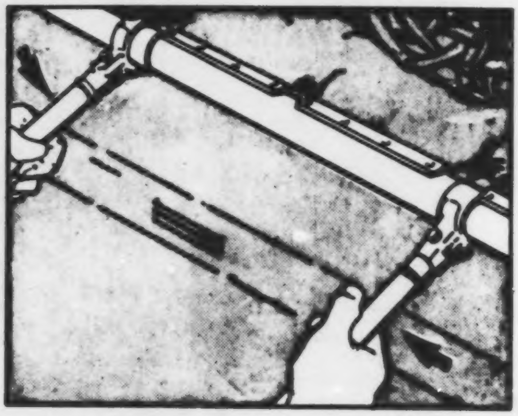
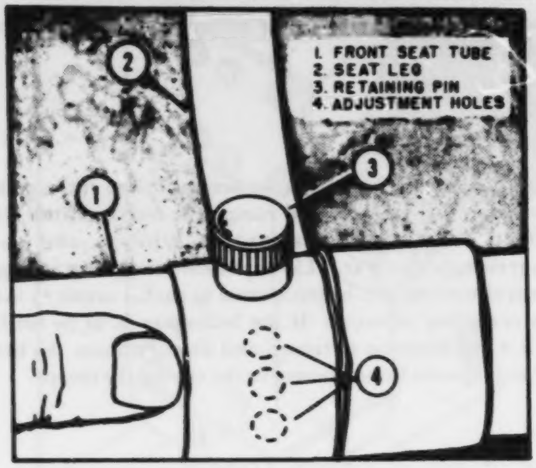


Figure 6-8. Troop Seat Installation (Sheet 1 of 2)

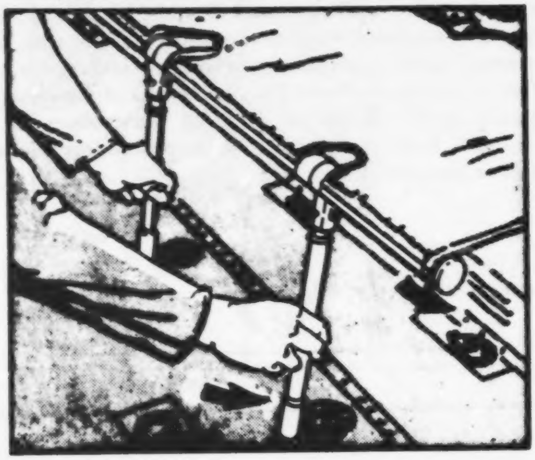
5 Adjust seat tension by engaging the spring-loaded retaining pin on the upper fitting of each seat leg in any one of four holes drilled around the front seat tube. The top hole gives the greatest tension, and the bottom hole adjusts the seat in its most relaxed position.



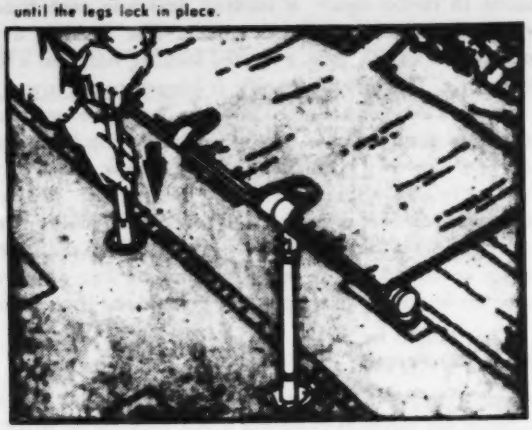
Note

Be sure the seat fabric is tightly stretched. If it is too loose, the seat will sag and the occupant will be uncomfortably seated on the spreader tube.

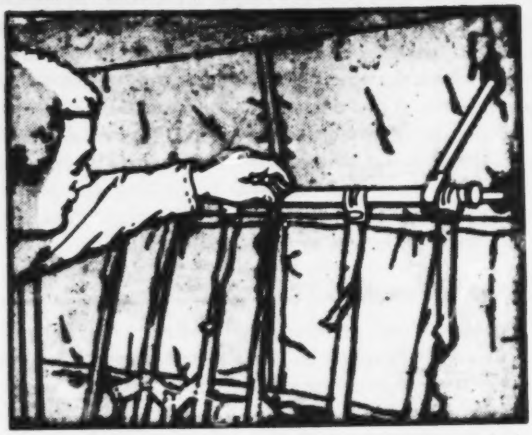
6 Apply tension to the seat by revolving the legs downward.



7 Place the legs directly over the studs on the floor and push down until the legs lock in place.



8 Attach the seat-back clips to the seat-back support tube.



9 Fasten the seat-back snap fasteners to form one continuous back rest.

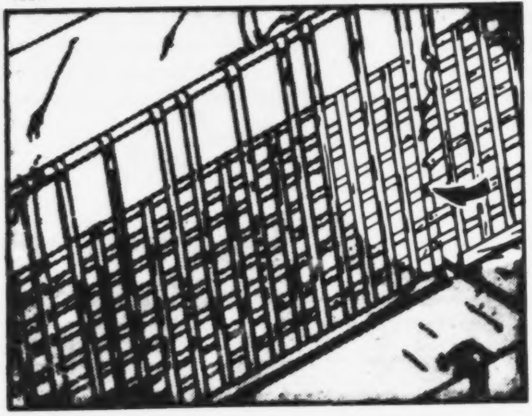


Figure 6-8. Troop Seat Installation (Sheet 2 of 2)

6-22. Litter Support Brackets.

Four litter support brackets are permanently attached to each litter pole and each litter strap. The brackets are spaced 18 inches apart. A locking device in each bracket secures the litter handles in place. The locking device consists of a handle clip, a slotted locking bar, and a locking handle. The locking handle is hinged to the lower jaw of the bracket. The slotted locking bar is hinged, cam fashion, to the locking handle. The handle clip is hinged to the upper jaw of the bracket and has a hook end which is engaged in one of the slots in the locking bar. When the locking handle is moved down, it forces the locking bar up and releases tension on the handle clip. When the locking handle is moved up, it pulls the locking bar down and forces the handle clip to a positive grip on the litter handle.

6-23. Litter Poles.

Twelve litter poles are provided for use in adapting the helicopter for medical evacuation. An attachment fitted to the bottom of each pole has two indentations, on opposing sides, which fit between two studs located in a floor channel. The upper rear side of the pole contains two keyhole slots by which the pole is anchored to studs on the seatback support tubes. A metal spring retainer inside the pole locks under one of the studs when the pole is installed. This prevents accidental dislocation of the pole. The retainer is released for litter pole removal by pulling the grommet which protrudes from the front of the pole. When not in use, the litter poles may be stowed at station 120.

6-24. Litter Straps.

Twelve litter straps are used with the litter poles to support the litters. The straps can be adjusted upward or downward by slide adjusters near the upper and lower ends of the straps. All of the straps are fitted at the top with slip-over hooks which are fastened to brackets in the strap stowage recesses. The lower end of each strap has a fitting for attaching the strap to a tiedown stud on the floor. The straps are stowed in the overhead recesses directly over the floor studs to which the straps will be attached. The stowage recesses are covered with canvas flaps which are zipped along two sides.

6-25. *Litter Installation.* The litters are installed as shown in figure 6-9.

6-26. Litter Removal.

The litters are removed by reversing the procedure shown in figure 6-9.

6-27. Litter Loading.

The loading of litters will be accomplished through the lowered aft cargo door and ramp. The forward litter tiers should be loaded first, top to bottom, and then progressively rearward. Litter patients requiring in-flight medical care should be positioned to enable access to injuries requiring attention. If the helicopter is to be loaded with a combination of troops and litter patients, the litter patients should be positioned to the rear of the troops.

6-28. Combination Seat and Litter Arrangement.

Combined troop and litter patient loads can be transported by arranging seats and litters as required. Table 6-1 gives the various combinations of seats and litters which can be used.

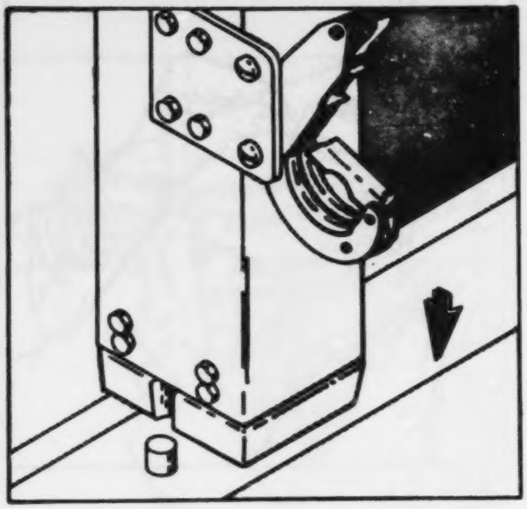
6-29. Static Line Anchor Cable.

A static line anchor cable is provided. The cable is normally stowed in a container (3, figure 6-20) located on the right side of the cargo compartment at station 160. When the static line anchor is installed, the cable is attached to the structure between stations 120 and 592. A static line retriever is provided with the static line anchor cable. The retriever is used in conjunction with the winch and is provided to haul-in the static lines at the end of the jumping exercise or to retrieve a hung up paratrooper in an emergency. Refer to chapter 4 for the procedures on using the static line retriever.

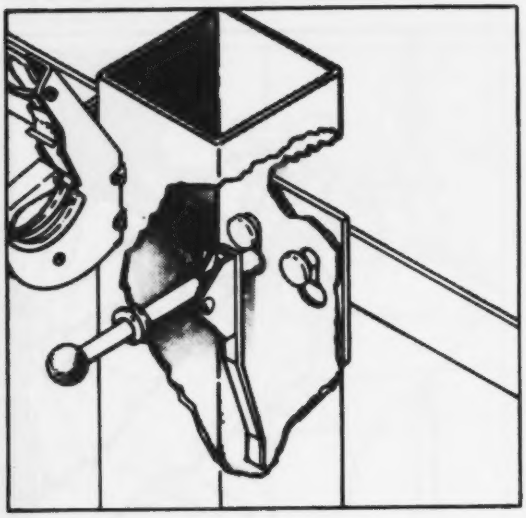
Table 6-1. Seat and Litter Arrangement Data

PERSONNEL		LITTER TIERS	SEATS	
SEATS	LITTERS	(4-MAN)	(1-MAN)	(3-MAN)
33	0	0	3	10
27	4	1	3	8
21	8	2	3	6
15	12	3	3	5
9	16	4	3	3
6	20	5	3	1
3	24	6	3	0

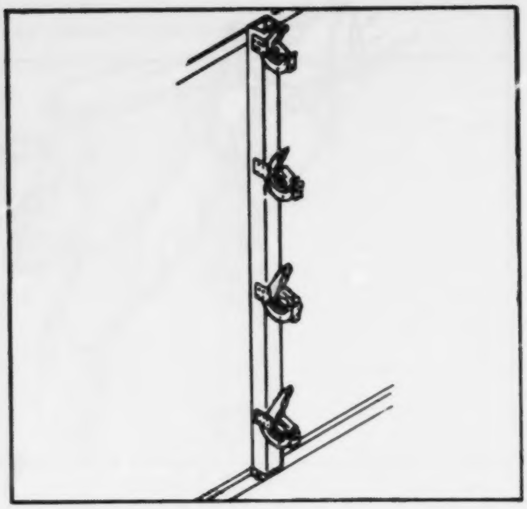
1 Stand the litter pole in the floor channel with the bottom pole attachment seated between the two studs located there.



2 Swing the upper end of the litter pole against the studs on the seat-back support tube and fit the keyhole slots on the back of the pole over the studs.



3 Move the litter pole downward until it is secured in position.



4 Remove all the litter support straps from the stowage recesses

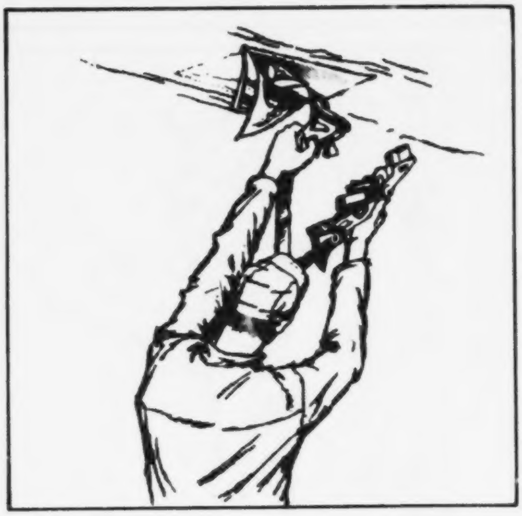
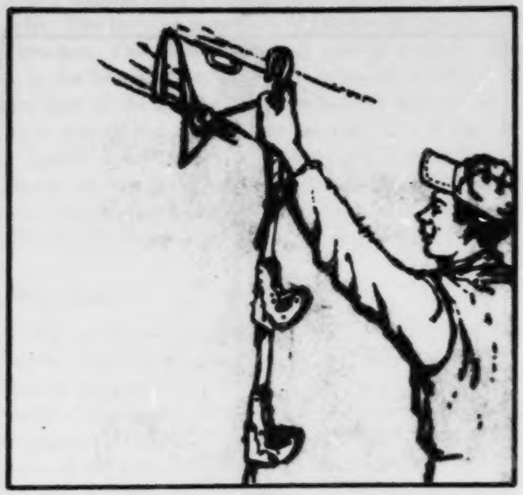
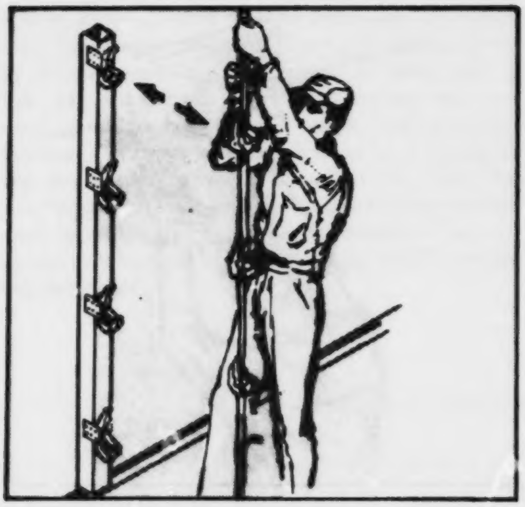


Figure 6-9. Litter Installation (Sheet 1 of 3)

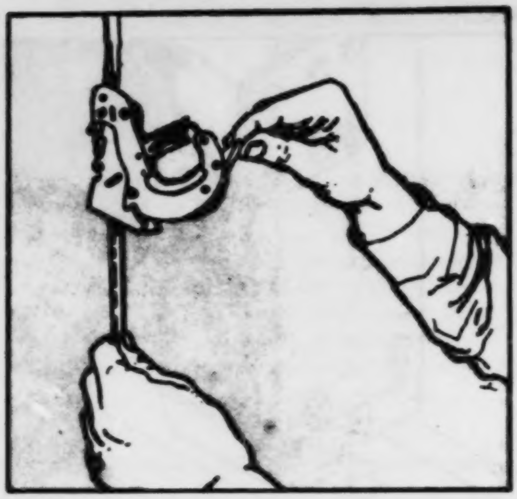
5 Attach the top ends of the straps to the brackets inside the stowage recesses.



6 Adjust each strap upward and downward until the strap support brackets are the same height as those on the corresponding litter poles.



7 Pull down on the locking handle of the litter support bracket.



8 Pull the handle clip away from the locking bar.

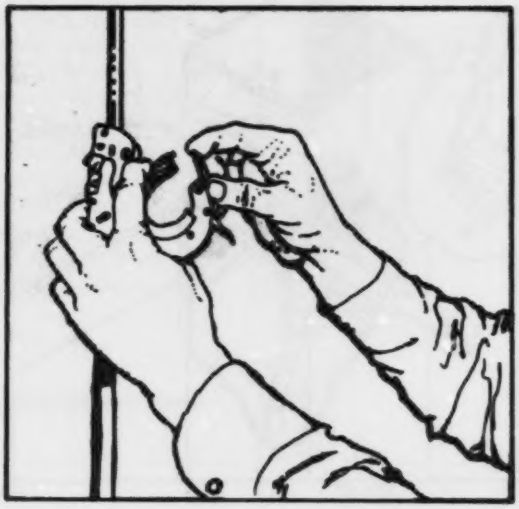
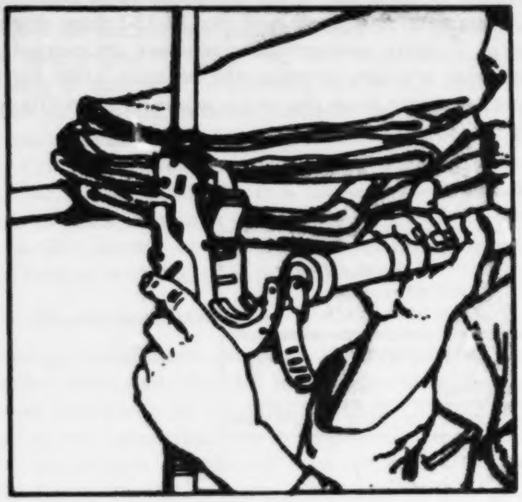
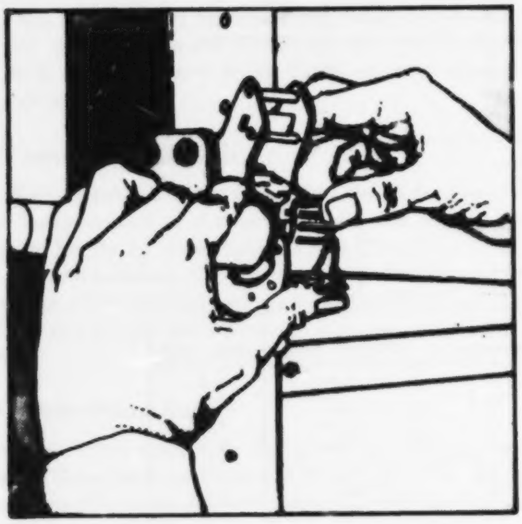


Figure 6-9. Litter Installation (Sheet 2 of 3)

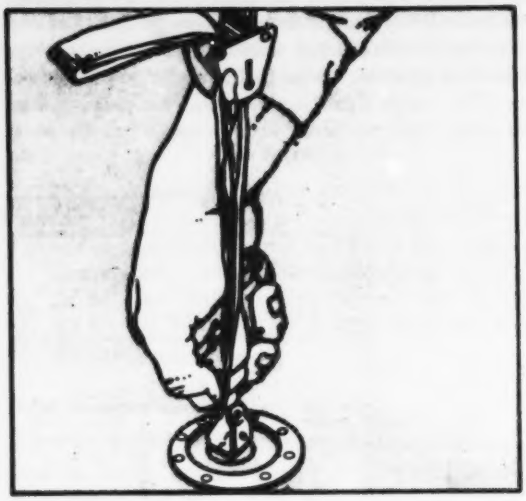
9 Place the litter handles into the litter support brackets.



10 When all four litter handles are in place, reengage the handle clip in the locking bar and lock the bracket by moving the locking handle upward.



11 Attach the fitting on the bottom of each litter support strap to the proper stud on the cargo floor. Do this by pressing inward on the spring lever, slipping the catch over the stud, and releasing the spring lever.



12 Tighten the litter support strap by pulling on the free end of the strap until the strap is sufficiently tight.

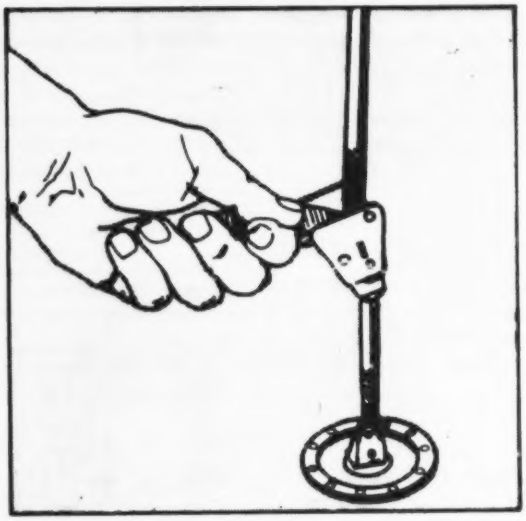


Figure 6-9. Litter Installation (Sheet 3 of 3)

SECTION V MISSION EQUIPMENT

6-30. Mission Equipment.

CH-47D mission equipment includes the M-24 armament subsystem, the M-41 armament subsystem, M-130 flare dispenser system, AN/ALQ-156 missile detector system, the cargo handling systems, the cargo hooks and the static line retriever. The cargo handling systems, the cargo hooks, and the static line retriever are included in the basic weight of the helicopter or are listed on the chart C for the particular helicopter. Figure 6-10 lists the weight and the moment/1,000 for the M-24 armament subsystem, the M-41 armament subsystem, and the M-130 flare dispenser system. If spare ammunition containers are carried on a particular mission, compute the moment/1,000 for each spare container from the cargo moments chart (figure 6-15).

ARMAMENT LOADING

M24 GUN (7.62 MM)
WEIGHT/GUN - 43.5 LBS
ARM (STA) 140
MOM/1000 -6.1

AMMUNITION

LH OR RH ARM = 140

ROUNDS	WEIGHT	MOM/1000
10	.7	.1
20	1.3	.2
40	2.6	.4
60	3.9	.5
80	5.2	.7
100	6.5	.9
120	7.8	1.1
140	9.1	1.3
160	10.4	1.5
180	11.7	1.6
200	13.0	1.8

M41 GUN (7.62 MM)
WEIGHT/GUN - 42.0 LBS
ARM (STA) - 584
MOM/1000 - 24.5

AMMUNITION

RAMP ARM = 584

ROUNDS	WEIGHT	MOM/1000
10	.7	.4
20	1.3	.8
40	2.6	1.5
60	3.9	2.3
80	5.2	3.0
100	6.5	3.8
120	7.8	4.6
140	9.1	5.3
160	10.4	6.1
180	11.7	6.8
200	13.0	7.6

M - 130 FLARE DISPENSER

DISPENSER
WEIGHT = 14.0 LBS ARM (STA) = 560
MOM/1000 = 7.8

FLARES

NO. CARTRIDGES	WEIGHT (LBS)	MOM/1000
1	0.5	.3
2	1.0	.6
3	1.5	.8
4	2.0	1.1
5	2.5	1.4
6	3.0	1.7
7	3.5	2.0
8	4.0	2.2
9	4.5	2.5
10	5.0	2.8
11	5.5	3.1
12	6.0	3.4
13	6.5	3.6
14	7.0	3.9
15	7.5	4.2

FLARES

NO. CARTRIDGES	WEIGHT (LBS)	MOM/1000
16	8.0	4.5
17	8.5	4.8
18	9.0	5.0
19	9.5	5.3
20	10.0	5.6
21	10.5	5.9
22	11.0	6.2
23	11.5	6.4
24	12.0	6.7
25	12.5	7.0
26	13.0	7.3
27	13.5	7.6
28	14.0	7.8
29	14.5	8.1
30	15.0	8.4

Figure 6-10. Mission Equipment Weights and Moments

SECTION VI CARGO LOADING

6-31. General.

This section contains information and instructions for loading and securing cargo in the helicopter. It lists and describes the items of equipment incidental to these operations, instructions for their use, and illustrations where necessary or desirable. In addition, this section deals with the factors of stress, balance, restraint, and methods and procedures essential to safe, effective delivery of cargo. The study and use of this data will help you load and unload cargo safely and efficiently. It is not the function of this section to teach principles of cargo loading. It is the function of this section to provide detailed information on cargo loading with regard to this helicopter.

6-32. Cargo Compartment.

The cargo compartment (figure 6-11) is 366 inches long, 90 inches wide, and 78 inches high. These dimensions are uniform throughout the cargo compartment. A hatch in the center of the cargo floor opens to provide access to the center cargo hook and the lower rescue door. The lower rescue door is opened for rescue operations, aerial loading, and external cargo transport operations. A hydraulically operated door and ramp provide a means for quick and efficient straight-in loading and unloading.

NOTE

Figure 6-12 shows the maximum cube size which can be taken into the helicopter thru either the main cabin entrance, utility hatch, or cargo loading ramp.

6-33. Main Cabin Entrance.

The main entrance door is located on the right side of the cargo compartment at the forward end and measures 66 inches in height by 36 inches in width. The door is composed of two sections; the upper section rolls inward and upward to a rest position overhead; the lower section opens outward and downward and serves as a step in the lowered position.

6-34. Utility Hatch Door.

The utility hatch door is in the center of the cargo compartment floor between stations 320 and 360. The door is hinged along its entire forward edge. It opens upward and forward to expose the lower rescue door and the cargo hook. The door is unlatched by pressing the knob marked PUSH, and is latched by pressing the unmarked knob.

6-35. Lower Rescue Door.

When closed, the lower rescue door forms a part of the fuselage bottom. It is accessible thru the utility hatch door. The lower rescue door is secured by four latches centered around the door perimeter. These latches are connected by linkage to an actuator marked OPEN and CLOSED. A handcrank, stowed in spring metal clips on the left side of the fuselage, is used to unlatch the door and turn the gears. A drive shaft, which is turned by the gears, moves the door actuator links. The door opens downward and aft underneath the fuselage where it remains during operations.

NOTE

When opening or closing the lower rescue door, be certain that the cargo hook is properly stowed and supported by the restraining straps. In addition, close the lower rescue door, using the actuator only to the point where the latch can engage; the latches will then lift the door and compress the door seal.

6-36. Cargo Compartment Floor.

The floor is made of extruded panels, riveted together in sections. Raised extruded ridges, running the entire length of the floor, provided surfaces on which cargo is moved. The flooring in the cargo compartment contains sections on either side of the centerline which are strengthened to serve as vehicle treadways. The flooring, from station 200 to 400 and from buttline 44 left to 44 right, rests on rubber vibration isolators which reduce overall internal load vibrations. Tiedown fittings (figure 6-13) for securing cargo are installed in the floor. There are also studs for attaching troop seats, litter supports, and the base plate for the maintenance crane. The flooring is covered with a walkway compound which provides a non-skid surface for personnel and for vehicles. In construction, the ramp floor is identical with the cargo floor.

CAUTION

Although tightening of the tiedown straps may be necessary to reduce internal load vibrations, excessive tightening of tiedowns attached to the outboard row of tiedown fittings will limit the effectiveness of the isolated cargo floor.

NOTE

Whenever possible, place all wheeled vehicles entirely on the treadways between stations 200 and 400.

6-37. Strength Areas.

The weight which the cargo compartment floor (figure 6-14) can support varies. These variations are largely due to differences in strength of supporting frames and fuselage construction, not because of varying floor strength. To gain the maximum benefit from the cargo compartment floor, the following definitions and weight limitations must be observed.

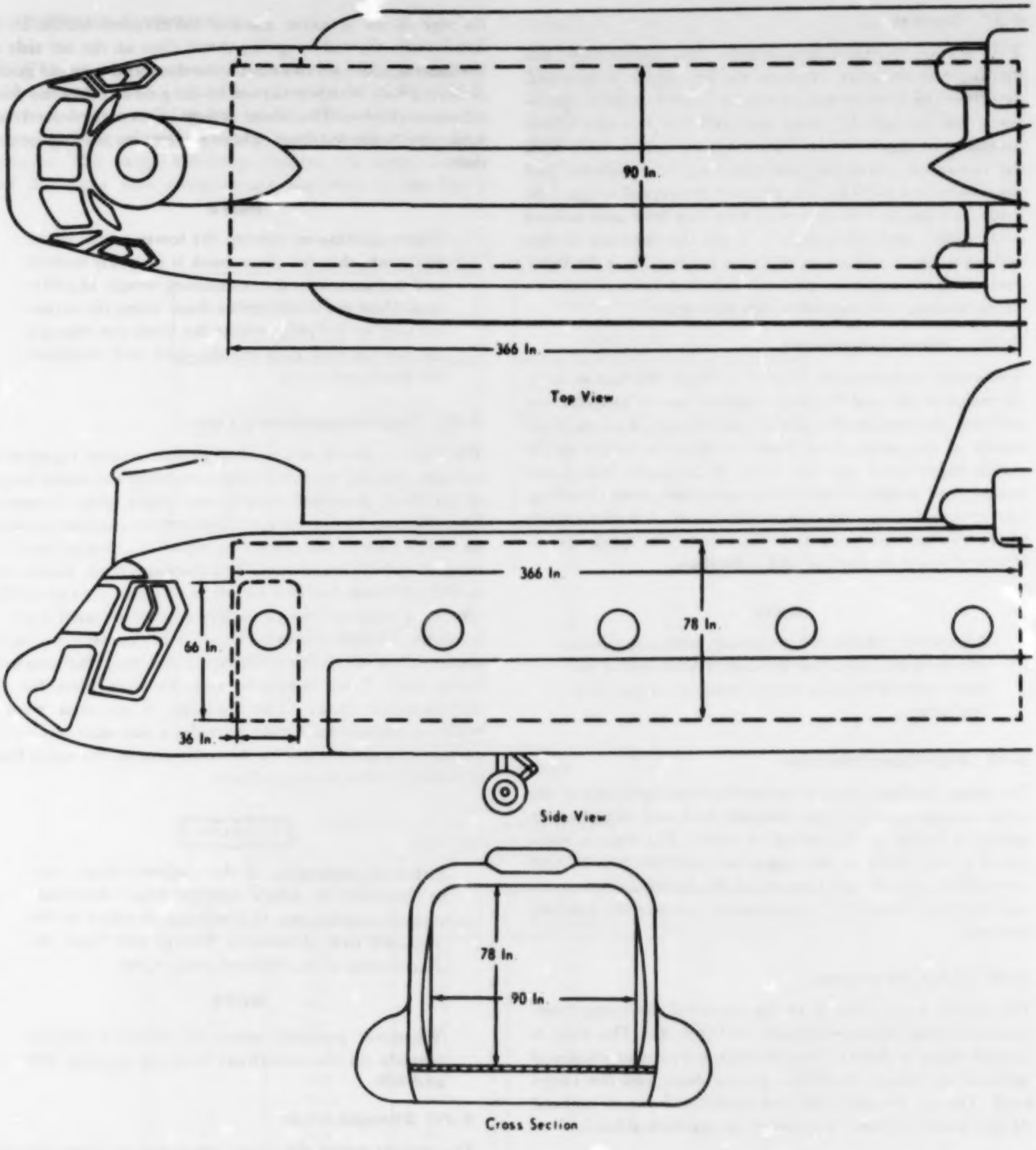
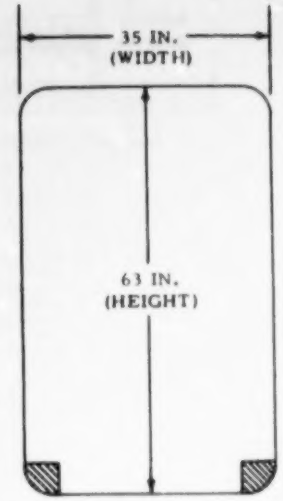

90 In.
366 In.
Top View
366 In.
78 In.
66 In.
36 In.
Side View
78 In.
90 In.
Cross Section

Figure 6-11. Cargo Compartment Dimensions

MAXIMUM PACKAGE SIZE TABLE
FORWARD DOOR--RIGHT SIDE

WIDTH (Inches)	HEIGHT--INCHES									
	53 & Under	54	55	56	57	58	59	60	61	62
		MAXIMUM LENGTH--INCHES								
12	249	246	242	238	234	223	170	170	170	165
13	233	230	227	224	221	211	162	162	162	157
14	217	215	213	210	208	199	154	154	154	150
15	205	204	203	199	197	187	147	147	147	144
16	195	194	193	189	187	176	141	141	141	138
17	186	185	183	180	178	166	136	136	136	133
18	177	176	174	172	170	157	131	131	131	128
19	169	168	166	164	162	149	126	126	126	124
20	161	160	159	157	155	142	122	122	122	120
21	155	154	153	151	148	135	118	118	118	116
22	149	148	147	145	141	129	114	114	114	112
23	143	143	142	140	135	124	111	111	111	109
24	138	138	137	135	129	119	108	108	108	106
25	133	133	132	130	124	114	105	105	105	103
26	128	128	127	125	119	110	103	103	103	101
27	125	124	123	121	115	106	101	101	101	99



NOTE:

Shaded part shows approximate area obstructed due to door opening linkage.

Figure 6-12. Maximum Package Size (Sheet 1 of 3)

6-38. *Uniformly Distributed Loads.* Uniformly distributed loads are those loads wherein the total weight of the item is equally spread over the item's entire contact area. Contact area is large compared to size and weight of the load.

6-39. *Uniformly Distributed Load Limits.* Compartments C, D, and E (figure 6-14) are limited to 300 psf. The cargo loading ramp (figure 6-14) is limited to 300 psf with a maximum total load of 3,000 pounds when the ramp is level with the cargo floor.

6-40. *Concentrated Loads.* Concentrated loads are those loads wherein the total weight of the item is supported by a contact area that is small compared to the size and weight of the load.

6-41. *Concentrated Load Limits.* Concentrated loads can be loaded on the treadways and on the walkway. The treadways aft of station 160 and ramp extensions are stressed for a total wheel load of 2,500 pounds. The treadways forward of station 160 and the walkway can be loaded to a total wheel load of 1,000 pounds. Concentrated loads are not to exceed 75 psi for pneumatic tires or 50 psi for block or roller-type wheels.

NOTE

The above floor loading limitations apply to the static weight of the item prior to applying any restraint devices.

NOTE

The minimum distance, in feet, between the centers of any two adjacent concentrated loads is determined by totaling the adjacent loads and dividing by 1,000.

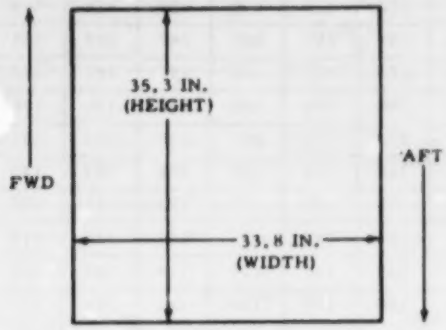
6-42. *Load Limits.*

Vehicles exceeding the limitations in paragraphs 6-39 and 6-41 may be loaded with the use of shoring, provided that the vehicle weights remain within the operating weight limits of the helicopter. In cases where the wheels of a vehicle cannot rest on both treadways because of a narrow wheel tread, shoring must be used to spread the load over the treadways. General cargo must not exceed floor pressure of 300 psf. An easy way to determine floor pressure of various loads is to divide the weight of the load by the contact area (in square inches or square feet).

MAXIMUM PACKAGE SIZE TABLE
BELLY UTILITY HATCH

WIDTH (Inches)	HEIGHT--INCHES																						
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	MAXIMUM LENGTH--INCHES																						
33 & Under	136	132	128	124	120	116	113	110	107	104	102	100	98	96	94	92	90	88	86	84	82	81	80

PACKAGES LOADED IN FORWARD DIRECTION



WIDTH (Inches)	HEIGHT--INCHES																						
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	MAXIMUM LENGTH--INCHES																						
33 & Under	146	140	135	130	126	122	118	114	111	108	105	102	99	96	93	91	89	87	85	83	81	80	79

PACKAGES LOADED IN AFT DIRECTION

Figure 6-12. Maximum Package Size (Sheet 2 of 3)

6-43. Compartment Identification.

The cargo compartment is divided, for weight and balance purposes, into three compartments designated C, D, and E, running fore and aft. (See figure 6-1.) When the cargo ramp is used as an extension of the cargo compartment, it is designated as F for weight and balance purposes. These compartment designations and their limiting fuselage stations are stenciled on the cargo compartment walls.

6-44. Compartment Capacities.

Based on a maximum distributed floor loading of 300 psf, the compartment capacities can be obtained by multiplying the floor loading by the floor area of the individual compartment; however, this weight may exceed present limitations. Figure 6-14 lists the maximum capacity of each compartment. In addition to the limitations in figure 6-14, compartment loads will be limited by those limitations set forth in chapter 5.

6-45. Tiedown Fittings.

Tiedown fittings (figure 6-13) for securing cargo are installed on the cargo compartment floor and on the ramp floor. All the fittings are D-ring types. There are eighty-seven 5,000-pound-capacity tiedown rings (83 in the fuselage floor and 4 in the ramp floor) and eight 10,000-pound-capacity tiedown fittings. The fittings are normally used with tiedown devices which will not exceed the limits of the fitting.

6-46. Five Thousand-Pound-Capacity Tiedown Fittings.

The eighty-three 5,000-pound-capacity tiedown fittings in the cargo compartment floor are equally spaced in five rows and are spaced 20 inches apart longitudinally. The four in the ramp are in a rectangular pattern. Each 5,000-pound-capacity fitting swivels freely and is capable of resisting a single maximum load of 5,000 pounds exerted along any radius of a hemisphere, the flat side of which is the surface of the floor. The fittings are hinged so that they can be seated in floor recesses when not in use.

MAXIMUM PACKAGE SIZE TABLE
RAMP DOOR

WIDTH (INCHES)	HEIGHT - INCHES															
	62 & Under	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	MAXIMUM LENGTH-- INCHES															
62 & Under	362	362	362	362	362	362	362	362	330	282	230	180	135	100	67	30
63	362	362	362	362	362	362	362	362	328	280	228	178	133	98	66	
64	362	362	362	362	362	362	362	362	326	278	226	176	130	96	64	
65	362	362	362	362	362	362	362	362	322	274	222	173	127	93		
66	362	362	362	362	362	362	362	362	318	270	218	169	123	90		
67	362	362	362	362	362	362	362	362	313	266	214	165	119	86		
68	362	362	362	362	362	362	362	357	307	260	208	160	114	81		
69	362	362	362	362	362	362	362	348	299	252	201	154	107	75		
70	362	362	362	362	362	362	362	339	290	243	193	146	99			
71	362	362	362	362	362	362	362	330	281	234	185	139	91			
72	362	362	362	362	362	362	362	321	272	226	177	131	83			
73	362	362	362	362	362	362	352	312	263	216	167	122	75			
74	362	362	362	362	362	362	339	298	250	203	156	112				
75	362	362	362	362	362	362	325	284	237	190	144	101				
76	362	362	362	362	362	348	311	270	223	177	132	90				
77	362	362	362	362	362	334	297	256	209	164	119					
78	362	362	362	362	346	316	278	237	191	147	104					
79	362	362	362	362	329	298	258	218	173	129	85					
80	362	362	362	362	310	276	236	195	151	108						
81	362	362	362	362	289	253	213	172	128	85						
82	362	362	362	362	267	230	188	148	105							
83	362	362	362	362	241	202	161	121								
84	362	362	362	362	213	174	133	93								
85	362	362	362	362	182	142	100									
86	362	362	362	362	146	105										
87	362	362	362	362	105											
88	362	362	362	362												
89	362	362	362	362												
90	362															

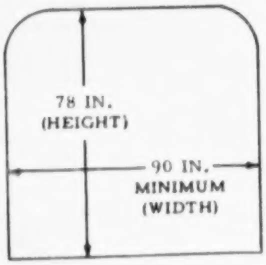


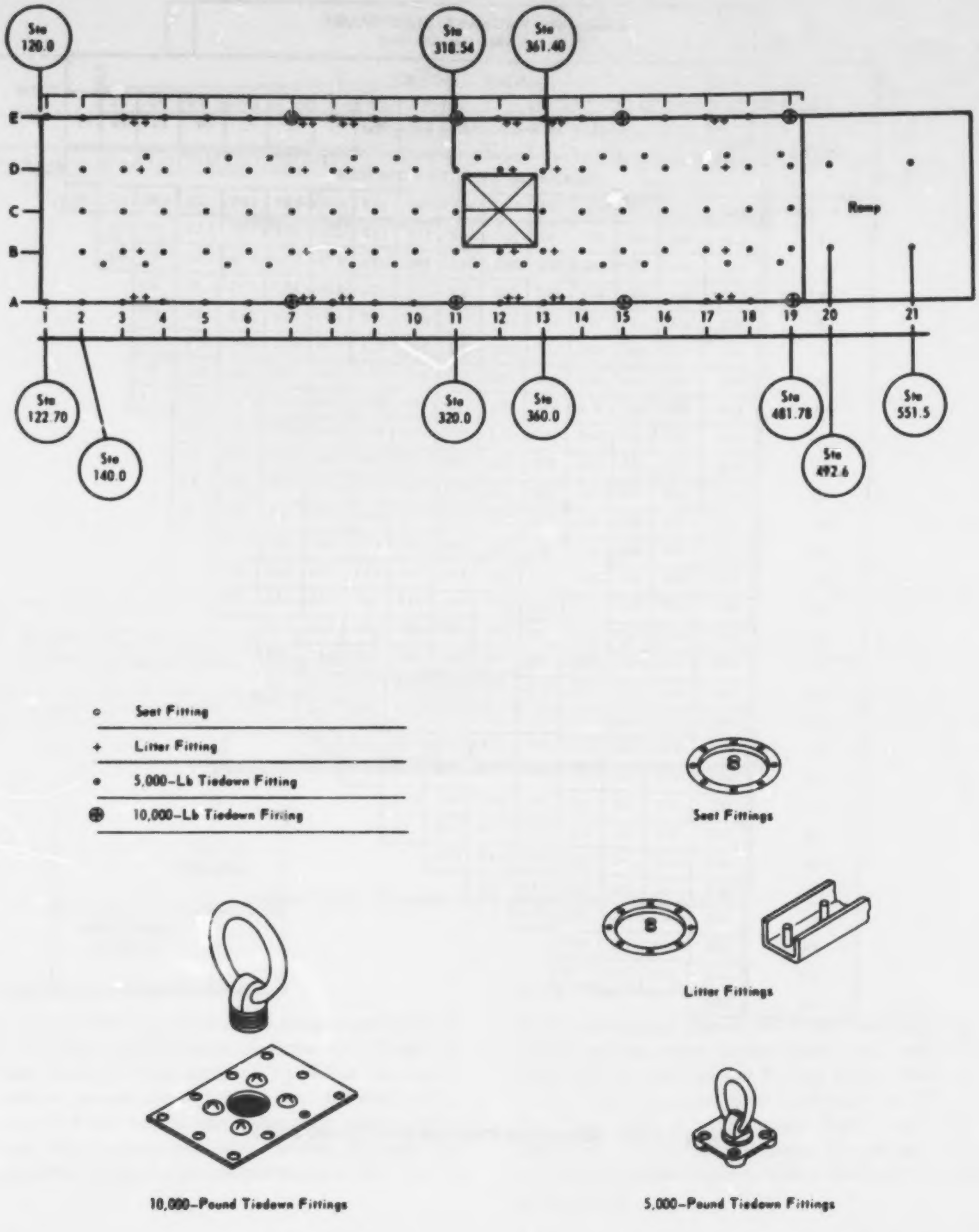
Figure 6-12. Maximum Package Size (Sheet 3 of 3)

6-47. Ten Thousand-Pound-Capacity Tiedown Fittings.

There are eight 10,000-pound-capacity tiedown fittings on the cargo compartment floor. Four fittings are interposed along both outboard rows of 5,000-pound-capacity fittings, spaced at intervals of 80 inches from station 240 to station 480. Because these fittings are not always used and because they might be in the way when installed, they are installed only when necessary. When they are to be used, the fittings are screwed into threaded receptacles at the fitting locations. When the fittings are not being used, threaded plugs are screwed into the receptacles to prevent entrance of foreign material and to protect the thread in the receptacles.

WARNING

The 10,000-pound-capacity tiedown fittings must be screwed into the threaded receptacles to full depth to achieve their rated capacity.


Sta 120.0
Sta 318.54
Sta 361.40
E
D
C
B
A
Ramp
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
Sta 122.70
Sta 140.0
Sta 320.0
Sta 360.0
Sta 481.78
Sta 492.6
Sta 551.5
○ Seat Fitting
+ Litter Fitting
• 5,000-Lb Tiedown Fitting
⊕ 10,000-Lb Tiedown Fitting

Seat Fittings

Litter Fittings

10,000-Pound Tiedown Fittings

5,000-Pound Tiedown Fittings

Figure 6-13. Tiedown Fittings

COMPARTMENT DATA

COMPARTMENT DESIGNATION	PILOTS' (A)	EQUIP (B)	CARGO (C)	(D)	(E)	RAMP (F)	TAIL (G)
CENTROID Inches from Ref Datum	75	108	181	303	425	*536	607
FORWARD LIMIT Inches from Ref Datum	21.5	95	120	242	364	486	584
AFT LIMIT Inches from Ref Datum	95	120	242	364	486	584	630.5
MAXIMUM CAPACITY Pounds			** 22875	** 22875	** 22875	3000	
FLOOR AREA Square Feet			76.3	76.3	76.3	*61.8	
VOLUME Cubic Feet			491.3	491.3	491.3	*373.8	
MAXIMUM CAPACITY Pounds per Square Foot			300	300	300	300	
TREADWAY Max uniformly distributed load over limited area of 1 square foot or max load per wheel.			2500	2500	2500	2500	
CENTER SECTION Between treadway-max uniformly distributed load over limited area of 1 square foot or max load per wheel			1000	1000	1000	1000	

NOTES:

1. RAMP (F) * based upon ramp open, level with floor plane.
2. Centroids for Compartments C, D, E, & F are based upon floor area.
3. All volumes based upon projection of floor area to ceiling.
4. **Do not exceed Gross Weight Limitations
5. In order to keep the emergency exits clear, it is recommended that cargo not be loaded forward of station 160.

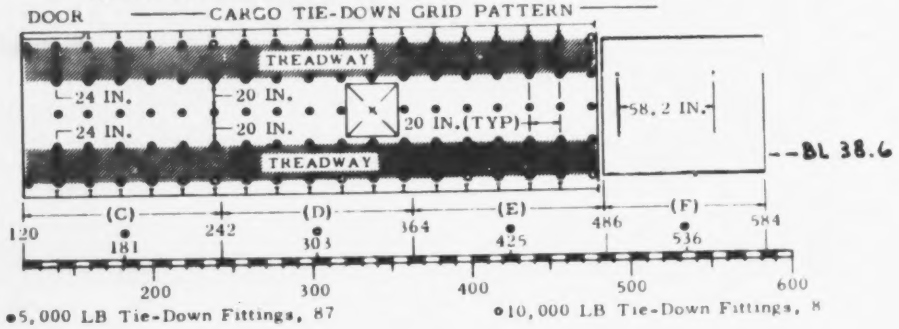

DOOR
CARGO TIE-DOWN GRID PATTERN
TREADWAY
24 IN.
24 IN.
20 IN.
20 IN.
20 IN.(TYP)
58.2 IN.
TREADWAY
BL 38.6
(C)
(D)
(E)
(F)
120
181
242
303
364
425
486
536
584
200
300
400
500
600
•5,000 LB Tie-Down Fittings, 87
o10,000 LB Tie-Down Fittings, 8

Figure 6-14. Compartment Data

CARGO MOMENT

EXAMPLE

WANTED

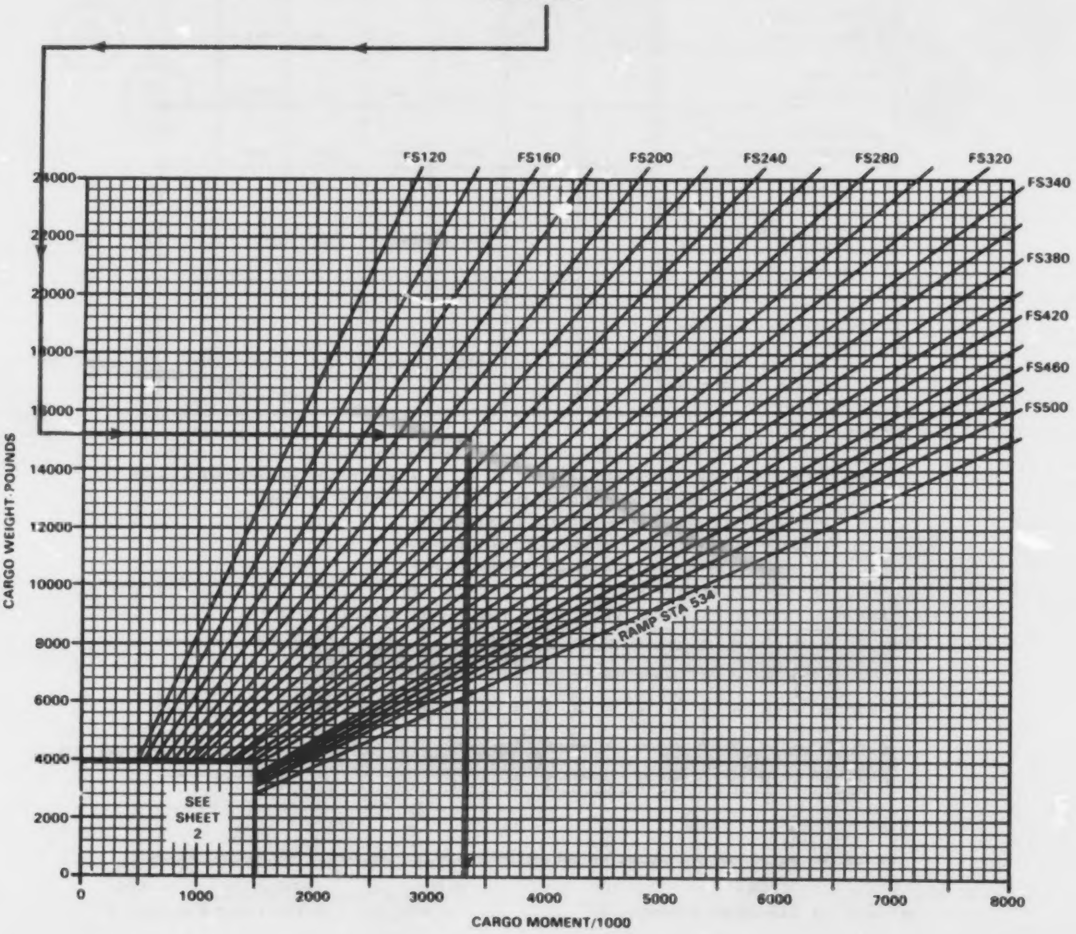
CARGO MOMENT

KNOWN

CARGO WEIGHT=15240 LB.
CARGO LOCATION=STA 210

METHOD

ENTER WEIGHT OF EACH
ITEM OF CARGO HERE.
MOVE RIGHT TO
CARGO LOCATION.
MOVE DOWN. READ
MOMENT=3200

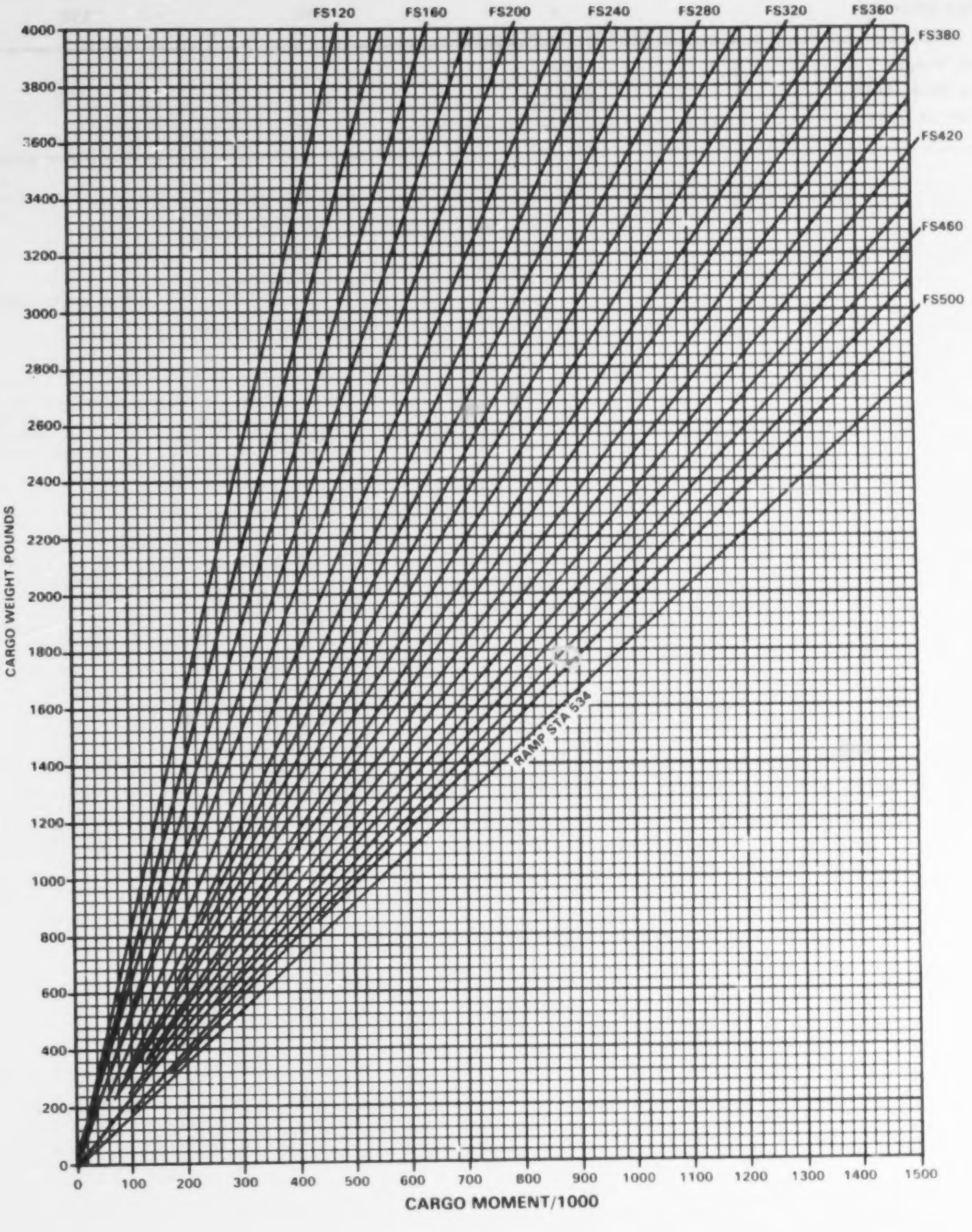


G

350

Figure 6-15. Internal Cargo Moments Chart (Sheet 1 of 2)

CARGO MOMENT



351

Figure 6-15. Internal Cargo Moments Chart (Sheet 2 of 2)

Table 6-2. Internal Cargo Handling System Weight and Balance

SECTION	WEIGHT (LB)	ARM	MOM/1000
Cabin Section	647	323	208981
Ramp Section	141	535	75435
Ramp Extension	51	554	28254
Ramp Extension Supports (Stowed)	26	527	13702
Ramp Support (Stowed)	9	550	7150
System Total Weight	878		
System Total MOM/1000	333.5		
System Center of Gravity	379.9		

TANDEM HOOKS (ARM= 329.0)

WARNING
OBSERVE CENTER OF GRAVITY LIMITS

EXAMPLE:

WANTED
CARGO MOMENT
OF LOAD ON
FORWARD AND
AFT HOOKS

KNOWN:

CARGO WEIGHT= 17,000 POUNDS

METHOD:

ENTER CARGO
WEIGHT HERE.
MOVE RIGHT TO
LINE. MOVE DOWN
READ MOMENT / 1000 = 5593

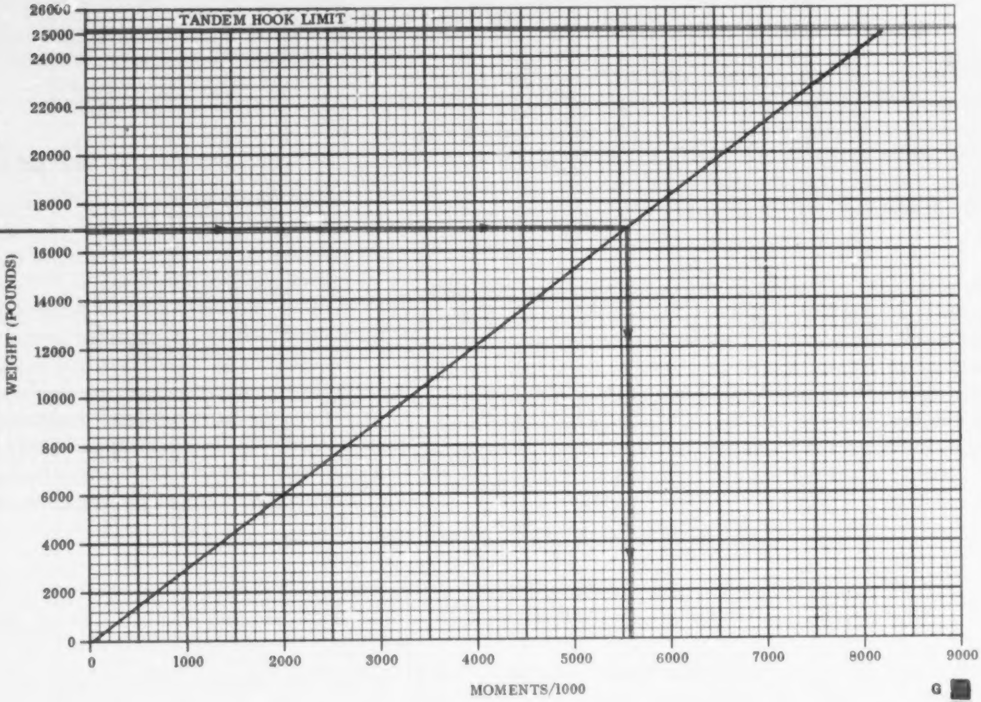


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Figure 6-16. External Cargo Moments Chart (Sheet 1 of 2)

CARGO HOOK MOMENTS

WARNING
OBSERVE CENTER OF GRAVITY LIMITS

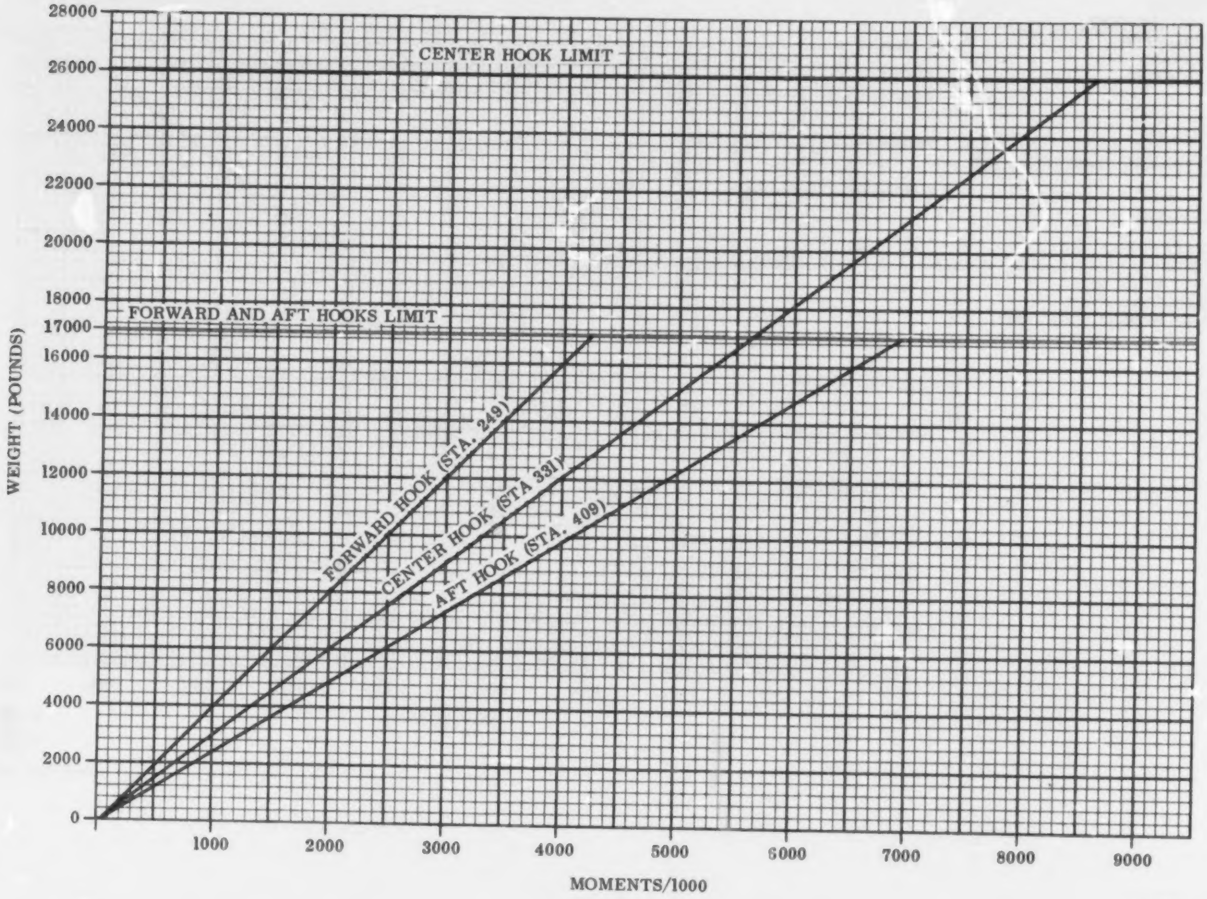

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Figure 6-16. External Cargo Moments Chart (Sheet 2 of 2)

6-48. *Cargo Loading Aids.*

The helicopter has a number of features to facilitate loading of cargo. Some of these features are parts of systems and are permanently installed; others are equipment which is stowed in the helicopter. The following paragraphs contain descriptions of items classed as loading aids. Specific instructions for some of these items may be found in other parts of this manual and are referenced.

6-49. *Cargo Loading Ramp.*

The ramp provides a means of quickly loading an unloading troops and cargo. (Refer to paragraph 6-53 thru 6-70.) It can also be used to support portions of a cargo load which exceeds the longitudinal dimensions of the cargo floor. When used for additional cargo space, the ramp must be positioned so that the ramp floor is level with the cargo floor. In this situation, the weight of the cargo item resting on the ramp must not exceed 3,000 pounds or 300 psf.

6-50. *Auxiliary Loading Ramps.*

Three auxiliary loading ramps are hinged to the aft end of the ramp. When the ramp is lowered, these auxiliary ramps (figure 6-17) are unfolded to provide flush contact between the ramp and the ground. The auxiliary loading ramps (figure 6-17) can be positioned to accommodate various vehicle tread widths or butted together to facilitate winching of bulk cargo. When not in use, the auxiliary ramps are stowed in an inverted position on the floor of the ramp or removed. One of the auxiliary loading ramps when attached to the ramp can also be used as a work platform. A collapsible support attached to the ramp bottom allows the ramp to be positioned at any convenient height when used as a work platform.

6-51. *Winch.*

Refer to chapter 4, section III.

6-52. *Tiedowns.*

Refer to paragraphs 6-92 thru 6-94 and figures 6-26 and 6-27.

6-53. *Cargo Door and Ramp.*

The cargo door and ramp has two sections: an upper section, or cargo door, and a lower section, or ramp. The door retracts into the ramp when the ramp is being lowered and extends when the ramp is being raised. The door is an integral part of the ramp and only provides closure; therefore, references made to the ramp will be understood to include the door and its related movements. The cargo door is jettisonable to provide an emergency exit. The cargo door and ramp (figure 6-17) is located at the aft end of the cargo compartment and is used for troop and cargo loading and unloading. In closed position, it conforms to the side contours of the fuselage. Internal locks in the ramp actuating cylinders prevent accidental opening and constitute the only locking mechanism for keeping the ramp closed. The ramp is hinged to the fuselage and opens rearward and downward to rest on the ground. When lowered to ground rest, the ramp inclines downward approximately 6.75° and maintains a uniform 78-inch overhead clearance of the cargo compartment. A continuous hinge runs the entire width of the aft upper edge of the ramp and holds the three auxiliary loading ramps. The auxiliary ramps unfold to bridge the gap between the ramp and the ground for vehicle loading and unloading. They can be adjusted laterally to accommodate various vehicle tread widths. Hydraulic power to operate the ramp is supplied thru the utility hydraulic system. For information about the ramp floor, refer to paragraph 6-49.

6-54. *Ramp Controls.*

The following paragraphs discuss the various controls necessary to operate the ramp.

6-55. Ramp Control Valve. Lowering and raising the ramp is controlled by a manually operated ramp control valve (figure 6-18) on the right side of the aft cargo compartment between the floor and the overhead at sta 490. The ramp control valve has three marked positions, UP, STOP, and DN (down). The valve can be reached from the outside thru a hinged panel on the aft fuselage.

6-56. Ramp Control Sequence Valve. A mechanically operated sequence valve (figure 6-18) controls the sequence of cargo door and ramp operation. The valve is below the ramp control valve at the ramp hinge line. A plunger on top of the valve is manually pressed to hold the cargo door at full open during ramp operation. The plunger can be locked in the depressed position by rotating a retainer pin which extends from the side of the valve (figure 6-19).

CAUTION

Do not press sequence valve plunger unless the ramp is down.

6-57. Pressure Actuated Valve. Ramp operation is stopped during cargo door operation by a hydraulic pressure actuated valve. The valve is located near the ramp control valve (figure 6-18). A plunger provides manual override of the valve if it sticks.

6-58. *(Deleted.)*

6-59. *(Deleted.)*

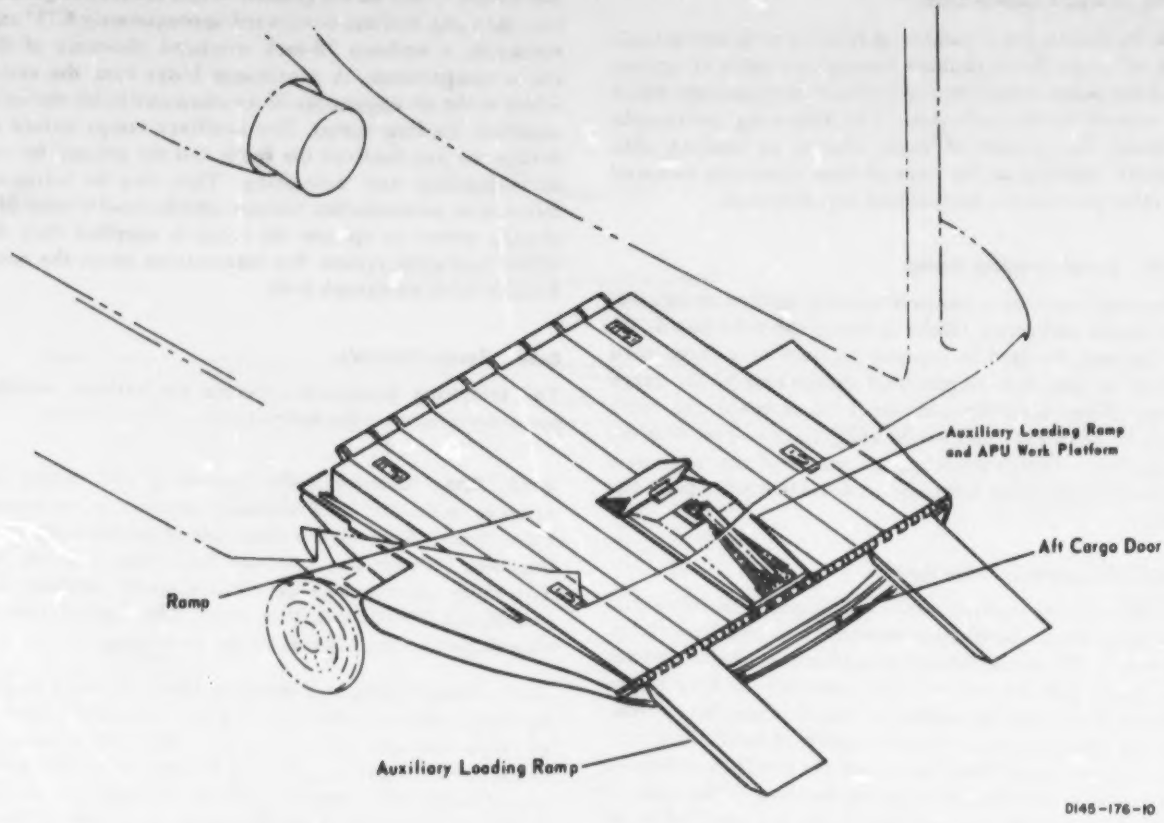

Figure 6-17. Cargo Door and Ramp

6-60. Ramp Isolation Switch. Refer to paragraph 2-126.

6-61. Accumulator Gage. A gage (figure 6-18) at station 534, right side, indicates apu accumulator pressure in psi. A pressure reading on the accumulator gage in excess of 2,500 psi is sufficient for operating the ramp.

6-62. Stowage Provisions.

All items of equipment needed for loading and securing cargo and for preparing the helicopter to carry troops or litter patients are stowed in the helicopter (figure 6-20).

6-63. Miscellaneous Equipment.

Some items of equipment, though not directly related to cargo loading, are important to the crewmembers responsible for cargo loading and delivery operations. Brief reference is made to these items in the following paragraphs.

6-64. Buffer Boards.

Buffer boards are installed in the cargo compartment on modified helicopters. The buffer board protects the heater ducts when the helicopter is loaded or unloaded.

6-65. Comfort Provisions.

Since the helicopter has a limited operational range, no provisions for personal comfort have been made.

6-66. Lighting System.

For a description of the lighting system, refer to chapter 2.

6-67. Emergency Equipment.

Information on items of emergency equipment and their locations in the helicopter are contained in chapter 2.

6-68. Emergency Exits.

Information on emergency exits, their locations, and instructions for their use are contained in chapter 9.

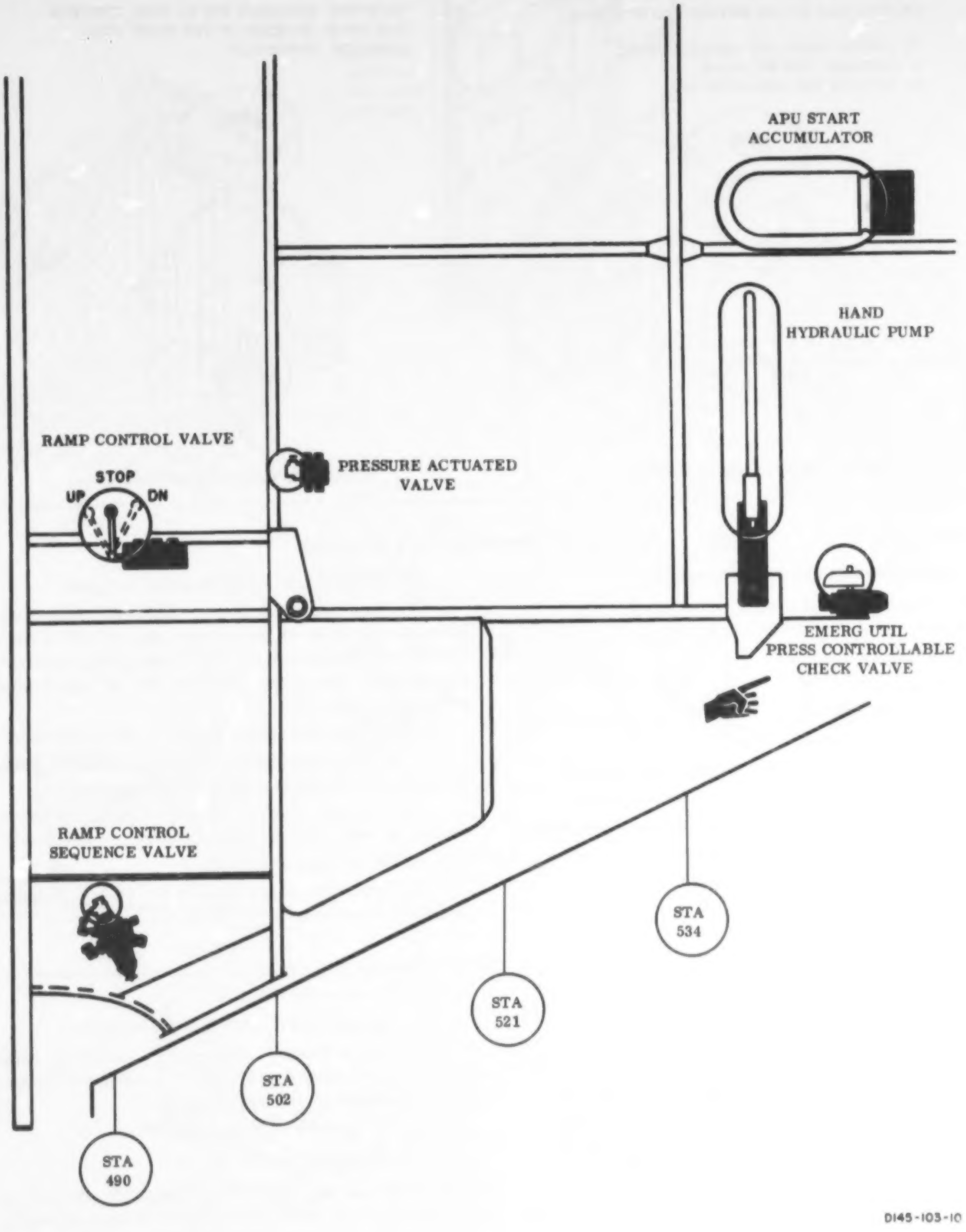
APU START
ACCUMULATOR
HAND
HYDRAULIC PUMP
RAMP CONTROL VALVE
STOP
UP
DN
PRESSURE ACTUATED
VALVE
EMERG UTIL
PRESS CONTROLLABLE
CHECK VALVE
RAMP CONTROL
SEQUENCE VALVE
STA
534
STA
521
STA
502
STA
490
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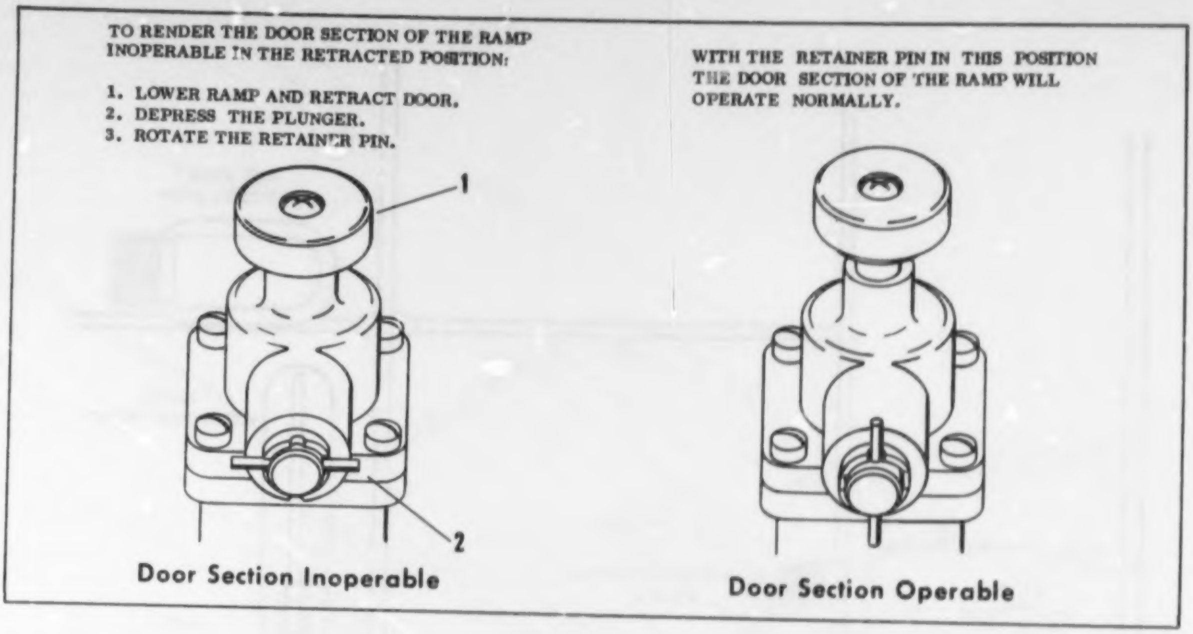
Figure 6-18. Ramp Controls


TO RENDER THE DOOR SECTION OF THE RAMP INOPERABLE IN THE RETRACTED POSITION:

1. LOWER RAMP AND RETRACT DOOR.
2. DEPRESS THE PLUNGER.
3. ROTATE THE RETAINER PIN.

WITH THE RETAINER PIN IN THIS POSITION THE DOOR SECTION OF THE RAMP WILL OPERATE NORMALLY.

Door Section Inoperable

Door Section Operable

Figure 6-19. Sequence Valve Operation

6-69. Equipment Loading and Unloading.

The following procedures should be observed in preparing the helicopter for a cargo transport mission:

a. Doors — Open.
b. Parking brake — On.
c. Troop seats — Stow.
d. Cargo compartment — Clean.
e. Tiedown devices — Check, for type and quantity.
f. 10,000 lb tiedown fittings — Install as required.
g. Loading aids — Check, for condition and operation.
h. Weight and balance data — Check.
i. Emergency equipment — Check.
j. Emergency exits — Inspect.
k. Cargo load — Inspect.

6-70. Ramp Operation.

6-71. Normal Operation.

WARNING

When the RAMP isolation switch is at OFF, be sure the RAMP CONTROL VALVE remains at STOP. If the RAMP CONTROL VALVE is moved to UP or DN, the ramp may free fall.

a. Lower the ramp as follows:

(1) RAMP isolation switch — ON.

NOTE

Perform step (2) and (3) only if the ramp is lowered with accumulator pressure.

(2) Apu accumulator gage — Check 2,500 psi or more. If the pressure reading is below 2,500 psi, operate the hand pump to build up pressure.

(3) EMERG UTIL PRESS valve — Open.

(4) Ramp control lever — DN, allowing ramp to lower to a position of ground rest, then STOP. If the ramp is to be adjusted to a level other than ground rest, or fully closed, with the cargo door in the retracted position, perform the following:

(a) Sequence valve plunger — Press and hold.

(b) Sequence valve plunger retainer — Rotate to the horizontal position to lock the plunger in.

(c) Ramp control lever — UP, until the ramp reaches the selected level, then STOP.

b. Raise the ramp as follows:

(1) Sequence valve plunger — Check, released if ramp and cargo door are to be closed.

NOTE

Perform step (2) only if accumulator pressure is used to raise the ramp.

(2) EMERG UTIL PRESS valve — Open.

(3) Ramp control lever — UP, allowing ramp to close. If accumulator pressure is not sufficient to raise the ramp, operate the hand pump.

(4) Ramp control lever — STOP.

6-72. In-Flight Operation.

The ramp can be operated at airspeeds up to Vne. At speeds up to 60 knots, the ramp will open normally. At speeds above 60 knots, air pressure from within the cargo compartment is required. To get this pressure, the vent blower can be turned on or the upper section of the cabin door can be opened.

CAUTION

The ramp is not to be opened below floor level during takeoffs and landings.

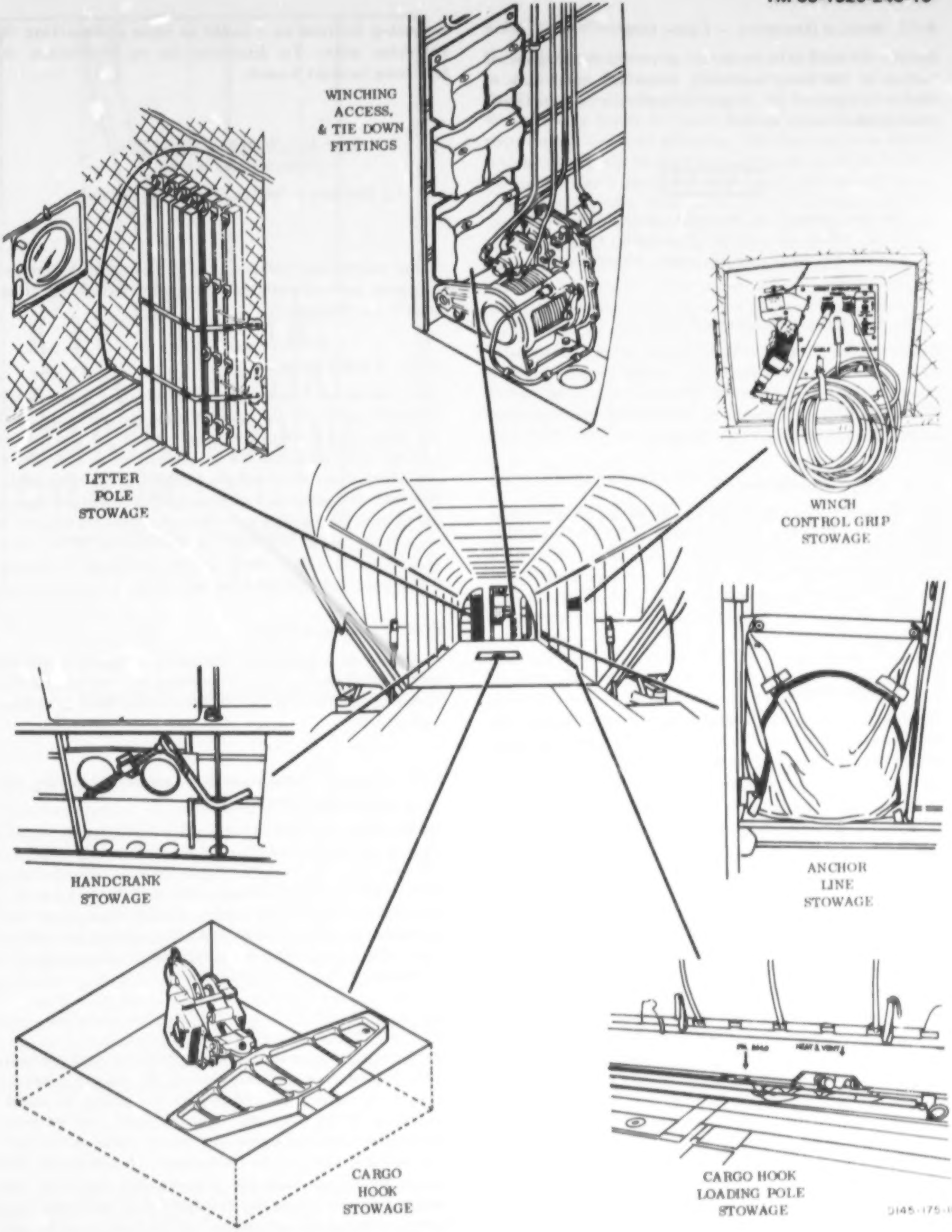

WINCHING
ACCESS,
& TIE DOWN
FITTINGS
LITTER
POLE
STOWAGE
WINCH
CONTROL GRIP
STOWAGE
HANDCRANK
STOWAGE
ANCHOR
LINE
STOWAGE
CARGO
HOOK
STOWAGE
CARGO HOOK
LOADING POLE
STOWAGE
0145-175-10

Figure 6-20. Stowage Locations

6-73. Manual Operation — Cargo Door.

Should the need arise to retract or extend the cargo door section of the ramp manually, insert the handcrank as shown in figure 6-21. Crank clockwise to retract. Crank counterclockwise to extend.

CAUTION

> Do not attempt to manually operate the cargo door when the utility hydraulic system is pressurized by the utility pump. Motor damage can result.

6-74. Preparation of General Cargo.

Before loading cargo, it is advisable to inspect items of cargo with regard to dimensions, weight, contact pressure, center of gravity, and hazards. This data will be helpful in determining the placement of the load in the helicopter and in computing weight and balance.

6-75. Cargo Dimensions.

Any item of cargo which appears to have critical dimensions for loading into the helicopter should be measured and checked against door and compartment dimension limitations. These limits are shown in figure 6-11 and 6-12. Items which exceed the limiting loading dimensions must be repacked to conform to these limits or be rejected for transport.

6-76. Cargo Weight.

Package weight of individual items of cargo should be legibly stenciled on an exterior surface. If not provided, the weight must be determined in order to plan cargo placement, to calculate contact pressure, and to compute helicopter weight and balance. The same rule applies to palletized cargo and vehicle loads.

6-77. Contact Pressure.

Contact pressure (figure 6-22) is calculated to determine whether the floor structure is strong enough to support a given item. The contact pressure of boxed and crated cargo is determined by dividing the weight of the item by the area of cargo which the item covers. The contact pressure of vehicles and other wheeled cargo is determined by dividing the weight of the item by the collective contact surface of the wheels supporting the item. If the contact pressure of a cargo item exceeds floor strength limitations, it can still be loaded using shoring and giving due consideration to helicopter load and center of gravity limits. (Refer to paragraph 6-89.)

6-78. Cargo Center of Gravity.

The center of gravity (cg) of each item of cargo must be determined in order to compute weight and balance by the station method. (Refer to paragraph 6-87.) As a rule, those items of cargo crated for transport will be marked with a cg. If the cg is not marked, it can be determined by simply balancing the item on a dowel or beam and marking the balancing point. To determine the cg of vehicles, the following formula is used:

$$\frac{\text{Rear Axle Weight x Wheel Base}}{\text{Vehicle Gross Weight}} =$$

$$\text{Cg Distance in Inches From the Front Axle}$$

If the weight and balance is to be computed by the compartment method (refer to paragraph 6-84), the cg of each item is not required.

6-79. Vehicle Load.

The same general rules that are observed in cargo loading apply to vehicle loading. In addition, fuel tank caps, radiator caps, and battery filler caps should be checked and secured. Fuel tanks should be checked to see that they are not filled above three-quarters capacity. Air trapped in a fuel tank will expand at altitude and force fuel out through the filler neck, creating a fire hazard. If fuel tanks are filled to capacity, some fuel must be drained off before the vehicle is loaded. Also, check tire pressures and, if necessary, deflate tires to prescribed limits.

6-80. Hazardous Cargo.

Items of cargo possessing dangerous physical properties, such as explosives, acids, flammables, etc., must be handled with extreme caution and in accordance with established regulations.

6-81. General Instructions for Loading, Securing, and Unloading Cargo.

There are three prime factors to be considered in properly loading the helicopter. These factors are weight, balance, and restraint. The weight of the cargo to be loaded must remain within safe operating limits, and the cargo must be restrained from shifting during takeoff, flight, and landing. Refer to TM 55-1500-210-L for equipment publications containing air-transportability instructions on specific items.

6-82. Weight.

The helicopter is weighed upon delivery and periodically thereafter to determine its empty (basic) weight. A record of helicopter weighing is maintained in Chart C of the Basic Weight and Balance Handbook. The last entry in Chart C reflects the current basic weight of the helicopter. To determine the allowable cargo load for a particular mission, the weights of the crew, the required fuel and other essential equipment, are added to the basic weight and the total subtracted from the helicopter gross weight. Obviously, the allowable payload weights will vary depending on the number of crewmembers assigned and the weight of fuel on board.

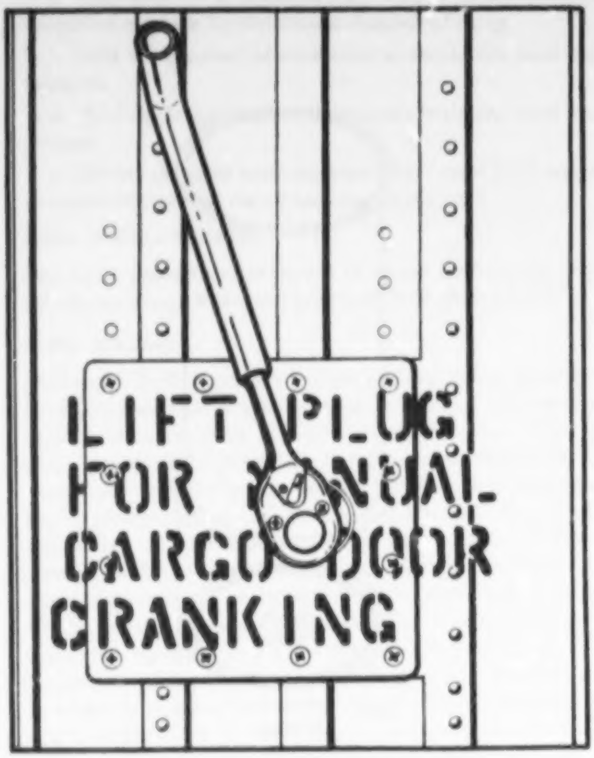


Figure 6-21. Cargo Door Cranking

6-83. *Balance.*

The balance point, or center of gravity (cg), of the basic helicopter is established by calculation. Any weight added or removed from the helicopter will cause the cg to shift forward or aft unless the weight is added or removed at the cg. If the cg shifts too far forward or too far aft, it will cause the helicopter to develop unsafe flight characteristics. For this reason, particular attention must be given to the placement of cargo within the helicopter. In this helicopter the cg range is great enough to allow placement of most normal cargo loads anywhere in the cargo compartment without exceeding critical cg limits. (Refer to section II.) It is recommended, however, that the heaviest portion of the load always be located near the longitudinal center of the cargo compartment.

6-84. *Restraint.*

Items of cargo within the helicopter are subject to the same forces which affect the helicopter in flight. (Refer to paragraphs 6-90 and 6-91.) These forces will cause the cargo to shift unless the cargo is restrained or tied down. To maintain helicopter balance and prevent injury to personnel, cargo must be restrained from shifting.

6-85. *Load Planning.*

Before loading cargo, the placement of individual items of cargo in the helicopter should be planned and then checked to determine if the planned arrangement falls within the cg limits in figure 6-30. There are three basic steps involved in load planning. The first step is to decide which method will be used to compute the cg of the load. If the compartment method is to be used, each item of cargo must be assigned a location in one of the three compartments. If the station method is to be used, specific station locations must be assigned to each item of cargo. The second step is to compute the cg of the load. If the load consists of a number of items of cargo, the compartment method described in paragraph 6-86 should be used. If the load consists of only a few bulky items, the station method described in paragraph 6-87 should be used. The third step is to check figure 6-30 to determine if the cg falls within the allowable limits. If it does, the cargo can be loaded; if not, the location of individual items should be rearranged until an acceptable loading plan is obtained.

6-86. *Compartment Loading.*

Loading by compartments provides a rapid means of computing the cg of a load and can be used whenever the cargo load consists of a number of items. The helicopter cargo compartment is divided into three compartments (See figure 6-23.) The centroid, or center of balance, of each compartment is located at station 181, 303, and 425, respectively. When using the compartment method, it is assumed that the weight of all the cargo in the compartment is concentrated at the centroid of the compartment. If an item of cargo extends into two or three compartments, the weight of the item should be proportionately distributed in each compartment. The cg of the cargo load is computed as follows: (See figure 6-23 for sample computation.)

a. Record the weight of cargo in each compartment.

b. Calculate the compartment moment by multiplying the total weight in each compartment by the station number of the compartment centroid.

c. Add the compartment moments.

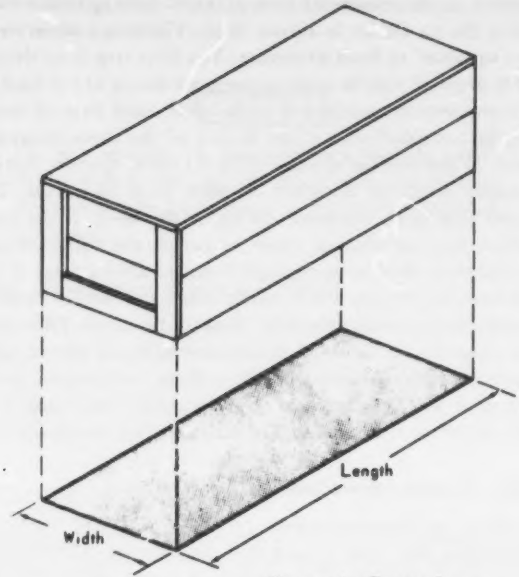
d. Add the weight in all compartments.

e. Divide the sums of the cargo moments by the total weight of the cargo. The result is the arm or the cg location of the load.

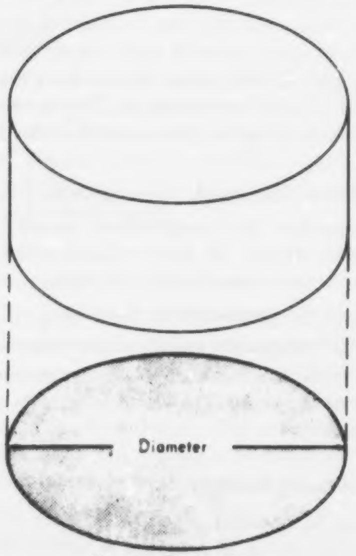
6-87. *Station Loading.*

Loading by stations provides a more precise method of computing the cg of a load and should be used whenever possible. To use this method, it is necessary to know the cg of each item of cargo. If the cg of an item is not marked, it can be determined by the procedure given in paragraph 6-78. Station loading requires that the cg of each item placed in the helicopter coincides with a fuselage station number. The cg of the load is calculated as follows: (See figure 6-24 for sample computation.)

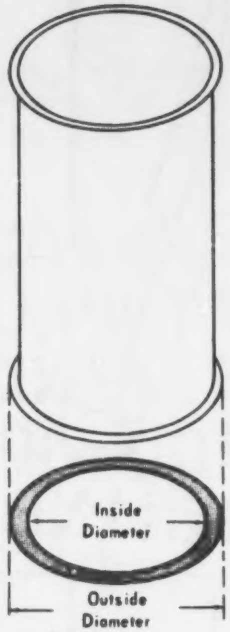
a. Record the weight and station number of each item of cargo.


Length
Width

Rectangular Contact Area
Area = Length X Width



Circular Contact Area
Area = Diameter^2 X 0.8

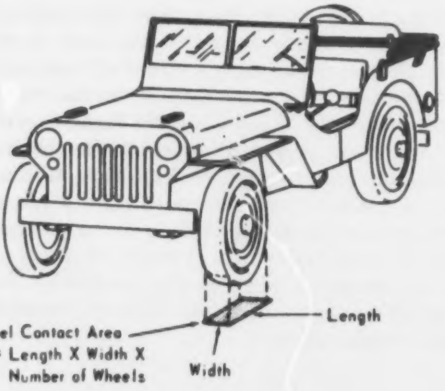

Inside Diameter
Outside Diameter

Rim Contact Area

Area = 0.8 x Outside Diameter^2
Minus 0.8 x Inside Diameter^2

Note

The contact area can be quickly approximated by reducing the dimensions to the smallest whole foot. For example, if the box is 3-1/6 by 6-1/2 feet, reduce it to 3 by 6 feet for a quick approximation.


Length
Width

Wheel Contact Area
Area = Length X Width X
Number of Wheels

Figure 6-22. Contact Pressure

b. Calculate the moment of each item by multiplying the weight of the item by the station number of its cg.

c. Add the moment of each item to obtain the total load moment.

d. Add the weights of each item to obtain the total load weight.

e. Divide the total load moment by the total load weight to obtain the arm or the cg location of the load.

6-88. Vehicle Loading.

The same procedures observed in cargo loading apply to vehicle loading. (Refer to paragraph 6-81 through 6-87.)

6-89. Shoring.

Shoring is used to protect the cargo floor and to distribute load pressure over a greater area of the floor. Planking 1 inch or 2 inches thick is used for these purposes. Shoring can often make the difference between being able to carry a given load and not being able to; however, it is important not to exaggerate the effectiveness of shoring. The spreading effect of shoring is limited to an area which is developed by extending a line downward and outward from the perimeter of the load contact surface, at an angle of 45°, until it intersects the surface on which the shoring rests. (See figure 6-25.) Thus the area over which the load is distributed is enlarged by the addition of a border equal in width to the thickness of the shoring. For example: shoring 2 inches thick under a box 12 inches square will add 112 sq. inches to the original contact surface of 144 sq. inches. Some vehicles have a tread width too narrow to allow the wheels to rest on the treadways. In this case, shoring must be used to reduce the contact pressure on the walkway to an allowable figure. In general, shoring is required for all wheeled platforms and dollies and for any item of cargo whose contact pressure exceeds the floor limitations described in paragraph 6-37 through 6-42.

6-90. Securing Cargo.

The helicopter is subjected to forces which result from air turbulence, acceleration, rough or crash landings, and aerial maneuvers. These same forces act upon the cargo in the helicopter and tend to shift the cargo unless it is firmly secure. Forward motion of the helicopter is the most rapid movement that will be encountered and since the cargo moves at the same rate of speed as the helicopter, forward movement is the strongest force that is likely to act on the cargo if the helicopter is suddenly slowed or stopped in a crash landing. Other forces tending to shift the cargo aft, laterally, or vertically will be less severe. The amount of restraint required to keep the cargo from moving in any direction is called the restraint criterion and is expressed in units of the force of gravity, or g's. In each case, the maximum force exerted by the item of cargo to be restrained would be its normal weight times the number of g's of the restraint criteria. In order to safely carry cargo, the amount of restraint applied should equal or exceed the maximum amount of restraint required. Restraint is referred to by the direction in which it keeps the cargo from moving. Forward restraint keeps the cargo from moving forward, aft restraint keeps the cargo from moving aft, and so on.

6-91. Restraint Criteria.

The following restraint factors are ultimate values and the minimum acceptable factors for crew and passenger safety.

Direction	Restraint Criteria
Forward	4.0 g's
Aft	2.0 g's
Down	4.0 g's
Up	2.0 g's
Lateral	1.5 g's

6-92. Restraint Devices.

Three types of restraint devices are recommended for applying the required restraint to the cargo. These devices are commonly called tiedown devices and are shown in figure 6-26. Each tiedown device has a rated strength which is the load, or force, it is guaranteed to withstand. When a sufficient number of tiedown devices are correctly attached to the tiedown fittings on the cargo floor and to the cargo, the tiedown devices will restrain the cargo from moving in any direction within the helicopter.

6-93. MB-1 Tiedown Device.

The MB-1 tiedown device is rated at 10,000 pounds and is used with tiedown chains of the same strength. At one end of the device is a hook which is attached to a tiedown fitting on the cargo floor; the other end of the device is slotted to admit a link of the tiedown chain and contains a levered quick-release fastener. Chain tension is adjusted by a turnbuckle in the center of the device. Normally, the MB-1 tiedown device is fastened to the 10,000-pound tiedown fittings. Operation of the MB-1 tiedown device is shown in figure 6-27.

6-94. CGU-1/B Tiedown Device.

The CGU-1/B tiedown device has a rated capacity of 5,000 pounds. It consists of a nylon strap with a fixed hook at one end and a hook equipped with a ratchet tightening device at the opposite end. Normally, the CGU-1/B tiedown device is fastened to the 5,000-pound tiedown fittings. Operation of the CGU-1/B tiedown device is shown in figure 6-27.

6-95. Effect of Tiedown Devices at Angles.

A tiedown device will withstand a force equal to its rated strength only when the force is exerted parallel to the length of the tiedown device. It is seldom possible to fasten a tiedown device in this manner. Instead, it is usually necessary to fasten the tiedown device to the cargo at some point above the floor, resulting in a loss of restraint strength. The strength of restraint is reduced in ratio to the engles formed by the tiedown device with the floor and the axis of the helicopter. Based on calculations, a 30° angle of attachment in the intended restraint direction causes a restraint loss of only 25 percent in that direction and is the most desirable angle. While causing a loss of restraint in one direction, imposing these angles on the tiedown device furnishes restraint in two other directions so that one tie-below the transmission oil temperature indicator. The switch positions are TEST, SCAN, FWD, AFT, MIX, LEFT, and RT. When the switch is set to TEST, the pointer on the transmission oil temperature indicator deflects full scale toward low temperature. The highest oil temperature among all transmissions is indicated. The remaining positions are used for selecting a particular transmission oil temperature indication. When selecting a particular switch position, be sure the switch is in detent. If the switch is not in detent, the oil temperature indicator will indicate -70°C.

2-141. Transmission Oil Caution Lights. Five transmission oil caution lights are on the master caution panel. The lights are marked XMSN OIL HOT, XMSN OIL PRESS, XMSN AUX OIL PRESS, and NO. 1 and NO. 2 ENG XMSN HOT. These lights, in conjunction with the transmission oil pressure and temperature indicators on the instrument panel alert the crew to impending transmission lubrication problems. The caution lights operate independently of the pressure and temperature indicators on the instrument panel. The XMSN OIL HOT light comes on when the main oil temperature in the reservoir of the forward, aft, combining, or either engine transmission exceeds 140°C. The hot transmission is identified by the oil temperature selector switch and indicator.

The XMSN OIL PRESS caution light comes on when main oil pressure drops below 20 psi in any transmission or aft rotor shaft pressure drops below 10 psi. The low-pressure system is identified by the transmission oil pressure selector switch and indicator on the instrument panel. If the XMSN OIL PRESS caution light comes on and the affected transmission cannot be determined using the selector switch, the condition may be caused by loss of aft rotor shaft oil pressure. Low oil pressure at the aft rotor shaft is indicated by the illumination of the AFT SHAFT light on the maintenance panel.

The XMSN AUX OIL PRESS caution light which is activated by individual aux oil switches, comes on when auxiliary oil pressure drops below 20 psi in the fwd or aft transmission and 10 psi in the combiner transmission. The transmission with the low pressure is identified by a lit AUX OIL PRESS indicating light on the maintenance panel.

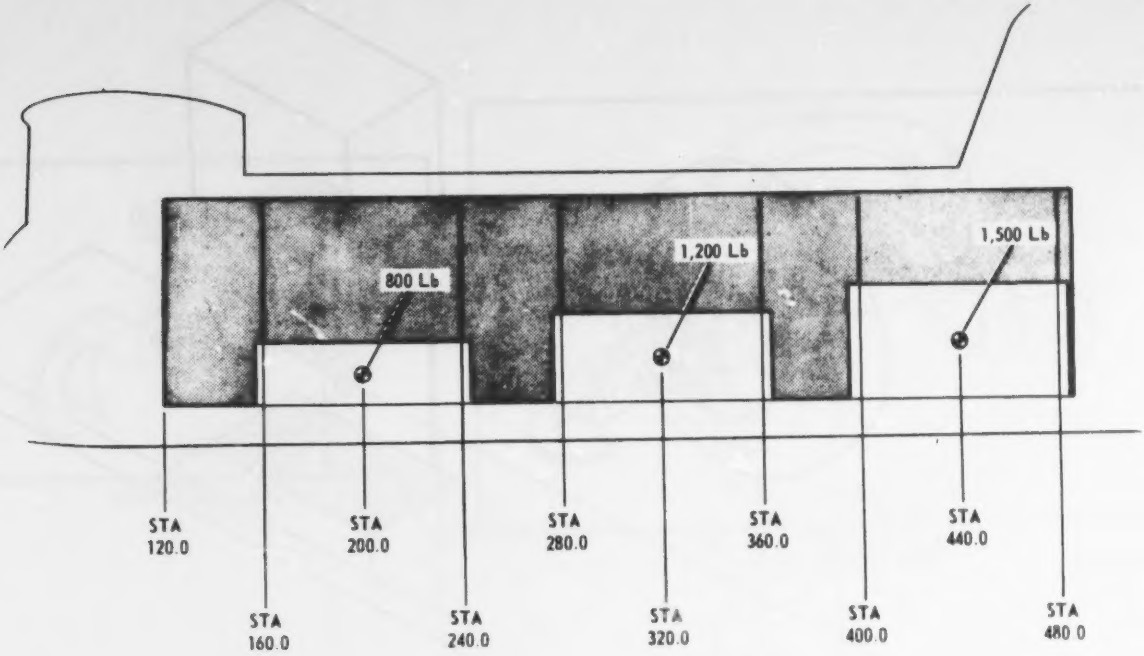
The NO. 1 or NO. 2 ENG XMSN HOT caution lights come on if oil temperature in either engine transmission exceeds about 190°C. The lights are turned on by a thermoswitch in each engine transmission. The thermoswitch monitors oil temperature in the transmission, not in the reservoir. The thermoswitch is part of a chip detector and temperature assembly in each engine transmission.

2-142. Transmission Chip Detectors. Chip detectors are installed in all transmission and aft rotor shaft thrust bearing lubrication systems. All chip detectors, except those in the engine transmission, are connected to the XMSN CHIP DET caution light on the master caution panel. Engine transmission chip detectors are connected to the ENG CHIP DET caution lights. All transmissions and the aft rotor shaft chip detectors are also connected to the TRANSMISSION CHIP DETECTOR indicators on the maintenance panel (fig. 2-27). When a chip detector is bridged by ferrous particles, the XMSN CHIP DET, or ENG CHIP DET caution light comes on. At the same time, the corresponding TRANSMISSION CHIP DETECTOR indicator on the maintenance panel will trip and change from an all-black indication to a black-and-white indication, identifying the transmission.

SECTION VIII ROTOR SYSTEM

2-143. General.

Lift is produced by a rotor system consisting of two fully articulated counter-rotating rotors. Each rotor has three fiberglass blades. The forward rotor is driven by the forward transmission thru a rotor drive shaft. The aft rotor is driven by the aft transmission thru a vertical drive shaft. The rotor head consists of a hub connected to three pitch-varying shafts by three horizontal hinge pins. These pins permit blade flapping. Stops on the top and the bottom of the hub limit the blade flapping motion. The aft rotor head is equipped with centrifugal droop stops which provide increased blade flapping angle for ground and flight operation. Covers are installed on the centrifugal droop stop operating mechanism. The covers prevent ice accumulation on the mechanism and ensure proper droop stop operation following flight in icing conditions. For information on use of the droop stop covers, refer to Chapter 8, Section IV. Mounted coaxially over the pitch-varying shafts are pitch-varying housings to which the blades are attached by vertical hinge pins. These pins permit blade leading and lagging. Each pitch-varying shaft is connected to the pitch-varying housing by a laminated tie bar assembly. The high tensile strength and low torsional stiffness of the tie bar retains the blade against centrifugal force and allows blade pitch changes about the pitch axis. Blade pitch changes are accomplished by three pitch-varying links connected from the rotating ring of the swashplate to the pitch-varying housing on each rotor blade. Cyclic pitch changes are accomplished by tilting the swashplate. Collective pitch changes are realized by vertical movement of the swashplate. Combined collective and cyclic pitch changes result from combined control inputs by the pilot. A direct-action shock absorber is attached to the blade and to the pitch-varying housing. When the inboard end of the shock absorber is disconnected, the blade can be folded in either direction about the vertical hinge pin.



Example

Problem: Three items of cargo are to be loaded into the helicopter. The weight and center of gravity of each item was found when the cargo was prepared for loading and is indicated above. The loading plan is to locate these items at stations 200, 320, and 440. Compute the CG of the total load.

Solution: Since there are only three items, the station method is used to calculate the CG of the load. Refer to paragraph 6-87, for step by step instructions.

	Weight X Station Number	Moment
Item 1	800 X 200	160,000
Item 2	1,200 X 320	384,000
Item 3	1,500 X 440	660,000

$$\text{CG of Load} = \frac{\text{Total Moment} \quad 1{,}204{,}000}{\text{Total Weight} \quad 3{,}500} = 344 \text{ (Station)}$$

Total Weight 3,500 Total Moment 1,204,000

Now that the center of gravity of the total load has been computed, compute the helicopter center of gravity.

Figure 6-24. Station Loading

down device provides restraint in three directions simultaneously. Thus, a tiedown device applied to provide forward restraint at angles of 30° also furnishes approximately 50 percent of its rated strength in lateral and vertical restraint.

6-96. Rules for Application of Tiedown Devices.

These rules should be followed when using tiedown devices.

a. Fasten the tiedown devices so that they form an angle of 30° with the cargo floor and 30° with the longitudinal axis of the helicopter. Come as close as possible to these angles.

b. Consider the strength of the tiedown fittings and the points of attachment on the load. A tiedown device is no stronger than its weakest point of attachment. Tiedown devices attached to the same tiedown fitting to provide restraint in one direction lose half their rated strength. A 10,000-pound tiedown device attached to a 5,000-pound tiedown fitting will only provide 5,000 pounds of restraint. Axles, towhooks, bumper supports, and vehicle frames are good points of attachment for securing most vehicles. Since general cargo items may not have points of attachment, the tiedown devices will be applied over or across the cargo items.

c. Use an even number of tiedown devices to maintain a symmetrical pattern. However, if there is a limited supply, it may be necessary to use an uneven number of tiedown devices.

d. Calculate the number of tiedown devices required for forward and aft restraints. If the tiedown devices providing forward and aft restraint are criss-crossed over the cargo, then adequate restraint in the lateral and vertical di-

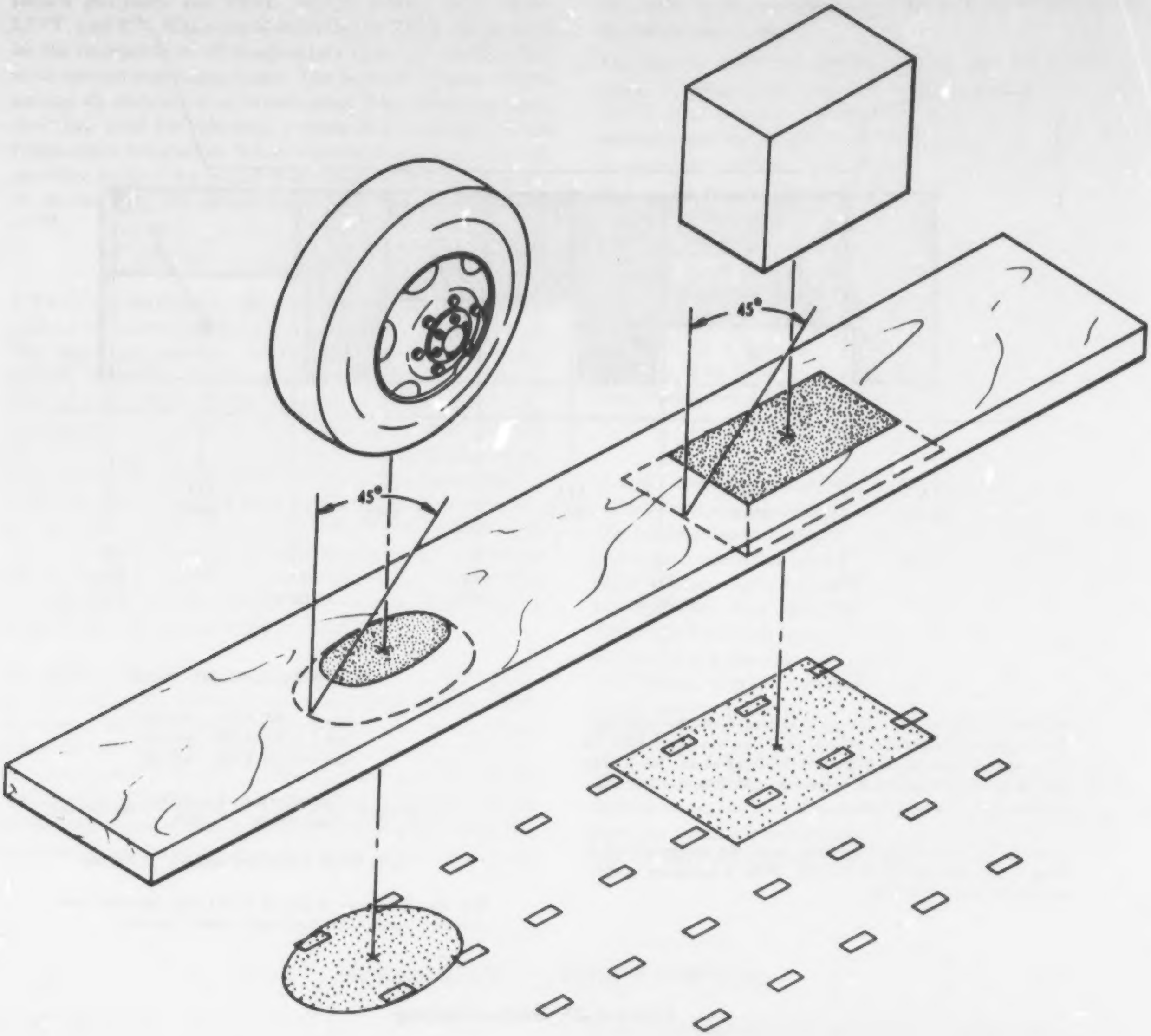


Figure 6-25. Effects of Shoring

rections will automatically be provided. If the tiedown devices providing forward and aft restraint are applied across the front and rear of the cargo, then lateral and vertical restraint will have to be provided according to calculated requirements. Vehicles will have sufficient lateral and vertical restraint if the forward and aft restraint is applied according to rules a. and c.

6-97. Calculation of Tiedown Devices Required.

The following method is used to calculate the number of tiedown devices required to restrain a load from moving in any direction, using the restraint criteria provided in paragraph 6-91.

PROBLEM: How many tiedown devices rated at 5,000 pounds will be required to restrain a load weighing 4,000 pounds?

CALCULATION:

a. Forward Restraint:

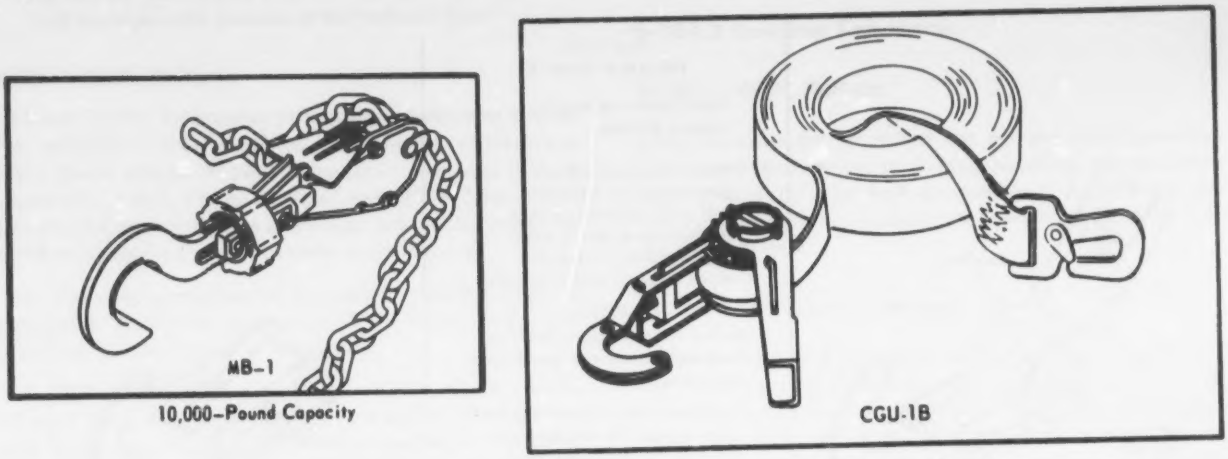
(Formula)

$$\frac{\text{Weight of Load x Restraint Criterion}}{\text{Rated Strength of Tiedown Device x 0.75}} = \text{Number of Devices Required}$$

(Solution)

$$\frac{\text{4,000 pounds x 4.0}}{\text{5,000 pounds x 0.75}} = \frac{16{,}000}{3{,}750} = 4.2$$

Since the equation yields a fractional number, this number is increased to the next whole number. Therefore, 5 tiedown devices will be required to provide forward restraint; 6 tiedown devices are desirable.



10,000-Pound Capacity

5,000 -Pound Capacity

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Figure 6-26. Tiedown Devices

b. Aft Restraint:

(Formula)

$$\frac{\text{Weight of Load x Restraint Criterion}}{\text{Rated Strength of Tiedown Device x 0.75}} = \text{Number of Devices Required}$$

(Solution)

$$\frac{4{,}000 \text{ pounds x } 2.0}{5{,}000 \text{ pounds x } 0.75} = \frac{8{,}000}{3{,}750} = 2.1$$

Since the equation yields a fractional number, this number is increased to the next whole number. Therefore, 3 tiedown devices will be required; 4 tiedown devices are desirable.

c. Vertical Restraint (Up):

(Formula)

$$\frac{\text{Weight of Load x Restraint Criterion}}{\text{Rated Strength of Tiedown Device x 0.50}} = \text{Number of Devices Required}$$

(Solution)

$$\frac{4{,}000 \text{ pounds x } 2.0}{5{,}000 \text{ pounds x } 0.50} = \frac{8{,}000}{2{,}500} = 3.2$$

If the forward and aft restraint is provided by tiedown devices applied over the cargo or attached to the cargo, no additional vertical restraint is required. Otherwise, 4 tiedown devices will be needed to provide vertical restraint.

d. Vertical Restraint (Down): The floor provides the downward restraint.

e. Lateral Restraint:

(Formula)

$$\frac{\text{Weight of Load x Restraint Criterion}}{\text{Rated Strength of Tiedown Device x 0.45}} = \text{Number of Devices Required}$$

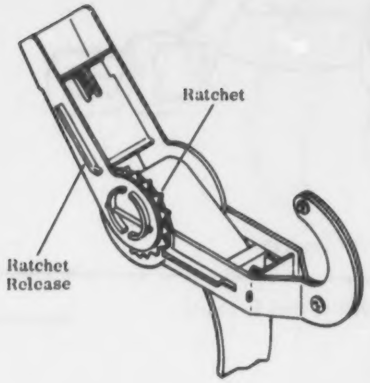
(Solution)

$$\frac{4{,}000 \text{ pounds x } 1.5}{5{,}000 \text{ pounds x } 0.45} = \frac{6{,}000}{2{,}250} = 2.6$$

If the forward and aft restraint is provided by tiedown devices applied over the cargo or attached to the cargo, no additional lateral restraint is required. Otherwise, 3 tiedown devices will be needed to provide lateral restraint; 4 tiedown devices are desirable.

6-98. Tiedown Methods.

Methods of applying restraint will vary depending on the tvpe of cargo making up the load. Vehicles, crated objects, and assorted items of general cargo will require different methods of application. (Refer to FM 55-450-2 for restraint methods.)


Ratchet
Ratchet Release

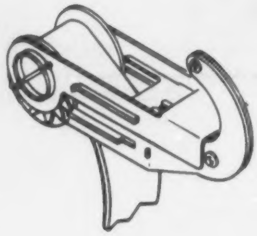
CGU-1/B TIEDOWN DEVICE

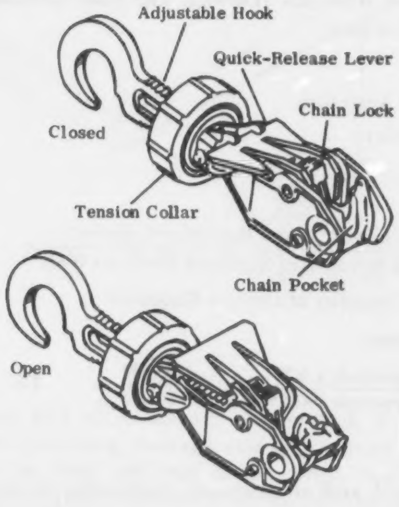
1. Hook tiedown device to tiedown fittings
2. To secure cargo after both hooks are attached, pull strap webbing through the tightening device until approximately 4 inches of slack remains between hooks

NOTE

Do not use any type of lever or mechanical means to assist hand ratcheting.

3. Hold the main web and the loose end of web with one hand and ratchet the tightening device with the other hand. This procedure will permit the webbing to wrap at least one full turn around the spindle of the tightening device. This procedure should provide sufficient friction to prevent slipping.
4. If slipping still occurs discontinue use of the tiedown device.




Adjustable Hook
Quick-Release Lever
Chain Lock
Closed
Tension Collar
Chain Pocket
Open

MB-1 TIEDOWN DEVICE

1 Extend adjustable hook by rotating tension grip.
2 Insert chain in chain pocket.
3 Push chain down until it bottoms and is sedured by the chain lock.
4 Rotate tension collar until chain is tight.
5 To release device under load pull up on quick release lever.

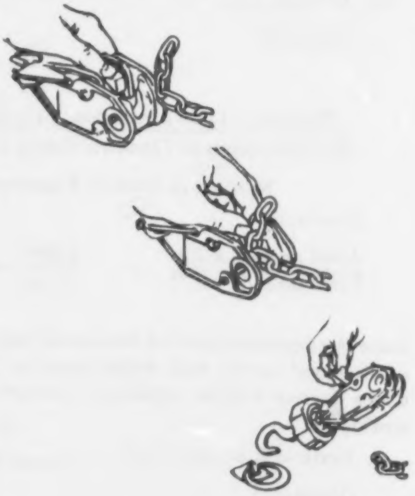


Figure 6-27. Operation of Tiedown Devices

CAUTION

Excessive tightening of the tiedown straps attached to the outboard row of tiedown fittings will limit the effectiveness of the isolated floor.

6-99. Vehicle Tiedown.

Because of the numerous points of attachment available, vehicles are the items of cargo easiest to tiedown. MB-1 chain device should be used to restrain vehicle loads (fig. 6-26). These devices should be fastened to the 10,000-pound tiedown fittings whenever possible. Vehicle tiedowns must include restraint for:

a. The sprung portion of the vehicle, which consists of everything above the springs, such as frame, body, cab, load bed, and any cargo in the vehicle.

b. The unsprung portion of the vehicle, which consists of everything below the springs, such as the wheels, axles, and the springs. Cargo in the vehicle must be considered as a separate item and must be securely fastened to the vehicle.

c. See figure 6-28 for typical methods of restraining the sprung and unsprung portions of a vehicle.

6-100. Bulk Cargo Tiedown.

A typical method of restraining large crates is shown in figure 6-29. If the crate is very heavy, an MB-1 tiedown devices should be used to provide forward restraint and should be fastened to the 10,000-pound tiedown fittings (fig. 6-13).

6-101. General Cargo Tiedown.

When a load is composed of numerous items of assorted cargo, it is practically impossible to restrain each item individually. The most suitable method of tying down such a load is to apply CGU-1/B straps over the assembled load longitudinally and laterally (fig. 6-29). To effectively use this method, the cargo must be loaded in such a way that the assembled items of cargo form a fairly even outline.

6-101.1 463L Pallet/Extended Range Fuel System (ERFS).

The restraint criteria capability of a 463L pallet/ERFS loaded to 7,500 pounds is as follows:

Direction	Load Factor
Forward	6g plus 1.5g down
Aft	3g plus 1.5g down
Lateral	2.25g plus 1.5g down
Up	6g
Down	3g

NOTE

The HICHS can yield locally under the above loads, but ultimate failure cannot occur; that is the cargo (e.g., pallet, ERFS) cannot become a flying object when the above loads are applied. The above ultimate load factors shall be applied to the entire HICHS. All other cargo will be restrained to the normal restraint criteria as stated in this chapter.

6-101.2 Loading Sequence.

6-101.3 463L Pallets.

Refer to table 6-2 to select the proper configuration for system components during loading. Up to three pallets may be winched or manually loaded on the system. Loading clearances are shown in fig. 6-29.2, 6-29.3 and 6-29.4.

6-101.4 Warehouse Pallets.

Refer to table 6-2 to select the proper configuration for system components during loading. Up to 8 to 10 warehouse pallets can be loaded into the helicopter provided that the weight and center-of-gravity requirements are within the limits specified as follows. The 40-inch side should be positioned across the handling system so that the 48-inch side is on the outboard rail. Pallets may be winched or manually loaded. During loading, the pallet should be fork lifted onto the ramp extension and balanced onto the ramp rollers. On the ramp, it should be pushed on board.

NOTE

All cargo must be properly restrained to ensure safe operation of the helicopter and safety of personnel. Loads must be restrained in accordance with procedures and guidelines in FM 55-450-2, Helicopter Internal Loads.

Individual warehouse pallets may weight up to 3,700 lb. However, in order to maintain floor isolation, the sum of the weights of longitudinally adjacent pallets must not exceed 4,300 lb. For example, pallets weighing 2,150 lb or less may be loaded without discrimination; a mix of pallets weighing, for example, 3,000 lb and 1,200 lb, would require alternate loading of a 3,000 lb pallet and a 1,200 lb pallet. If the load consists entirely of pallets weighing in excess of 2,150 lb, the pallets must be spaced longitudinally such that the distance, in inches, between the forward edge of one pallet and the forward edge of the subsequent pallet will not be less than W/45.2 when W is the average pallet load in pounds. For example, a load of pallets weighing 3,000 lb each would need to be spaced 3000/45.2 = 66 inches center to center apart. Pallets that are spaced longitudinally will require tiedowns for longitudinal, lateral and vertical forces. In this situation there is no requirement to use the barrier systems.

6-101.5 Wheeled Vehicles.

Refer to table 6-2 to select the proper configuration for system components during loading. Winch or manually load the vehicles into the helicopter.

6-101.6 Personnel.

The Internal Cargo Handling System is compatible for personnel only or for both cargo and personnel. If both are loaded, the cargo must be forward of the personnel for safety.

6-101.7 Miscellaneous Cargo.

Place on a pallet or skid as desired. If a 6/E (463L) Pallet is used, secure the pallet with the locks or retractable flanges. Straps or chains may be used as required.

6-101.8 Mixed Cargo.

Any of the previous cargos may be mixed as desired. The only limitation is space.

6-101.9 Load Dumping from Ramp.

Dumping from the ramp is not a routine operation, but under urgent conditions can be accomplished as follows:

a. Aircraft at full stop.

b. Remove ramp extensions and rollers if installed.

c. Load released, but under control and moved to aft cabin ramp with ramp slightly in up position.

CAUTION

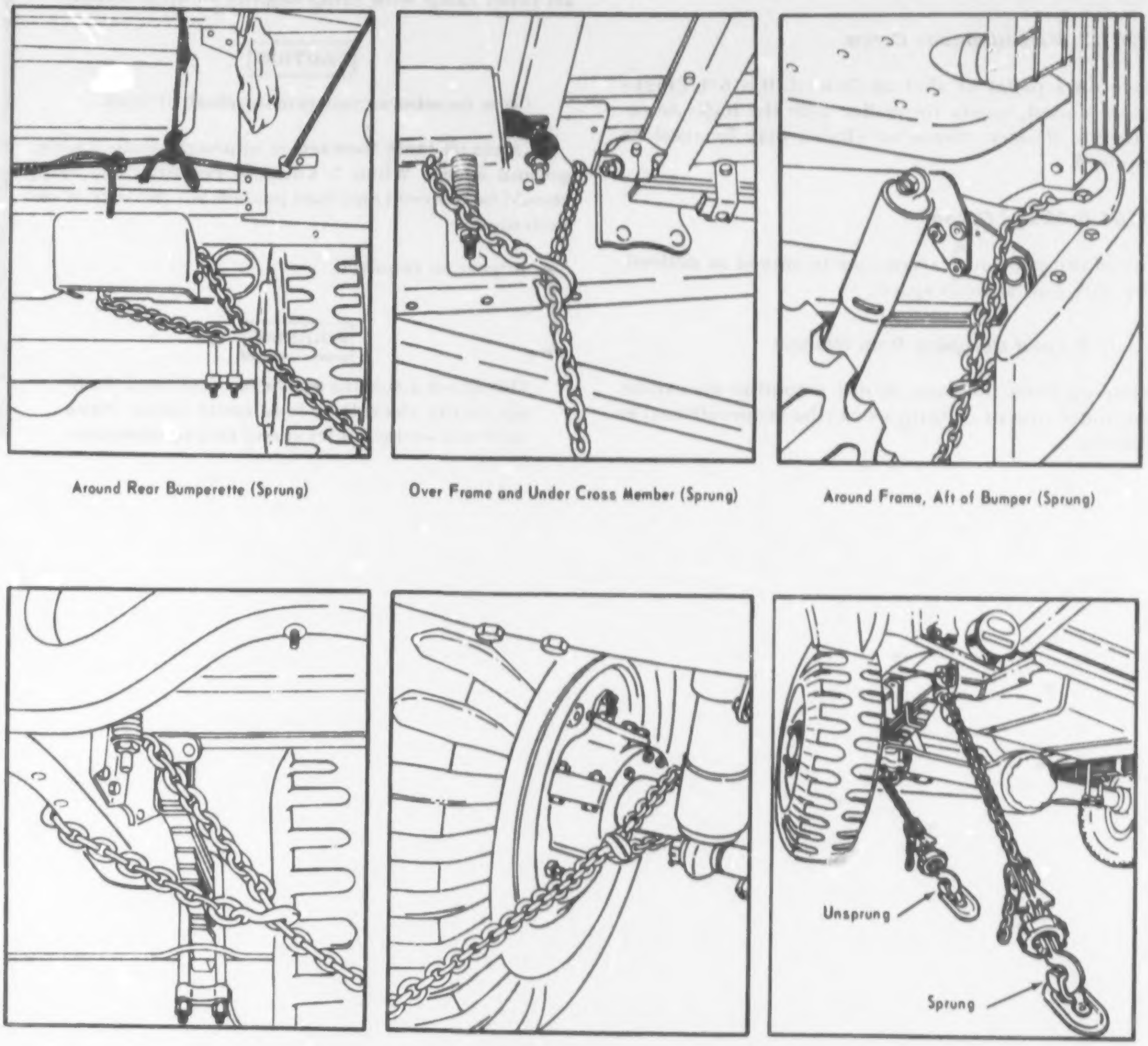
Crew members must remain clear of load.

d. Aircraft taxis forward at approximately 5 knots ground speed. When 5 knots is reached, the ramp should be lowered and load pushed out the rear of the helicopter.

e. Repeat as required.

WARNING

This is not a routine operation and some damage to the aircraft or load could occur. Make sure taxi surface is level and free of obstacles.



Around Rear Bumperette (Sprung)

Over Frame and Under Cross Member (Sprung)

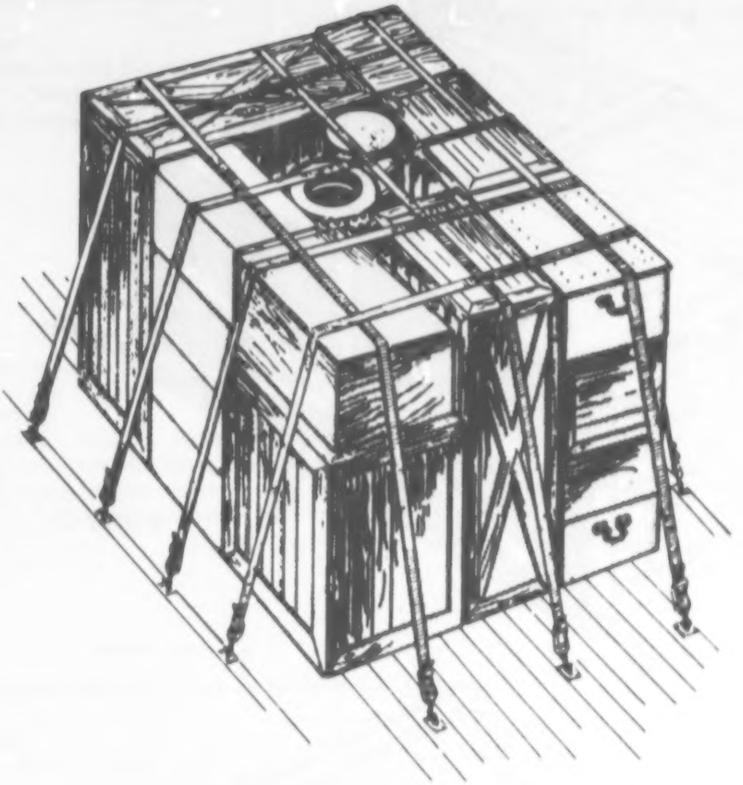
Around Frame, Aft of Bumper (Sprung)

Around Frame (Sprung)

Around Axle (Unsprung)

MB-1 Tiedowns Attached To Floor Fittings

Figure 6-28. Restraining Sprung and Unsprung Vehicles



VIEW 1
General Cargo Tiedown

VIEW 2
Vehicle Tiedown

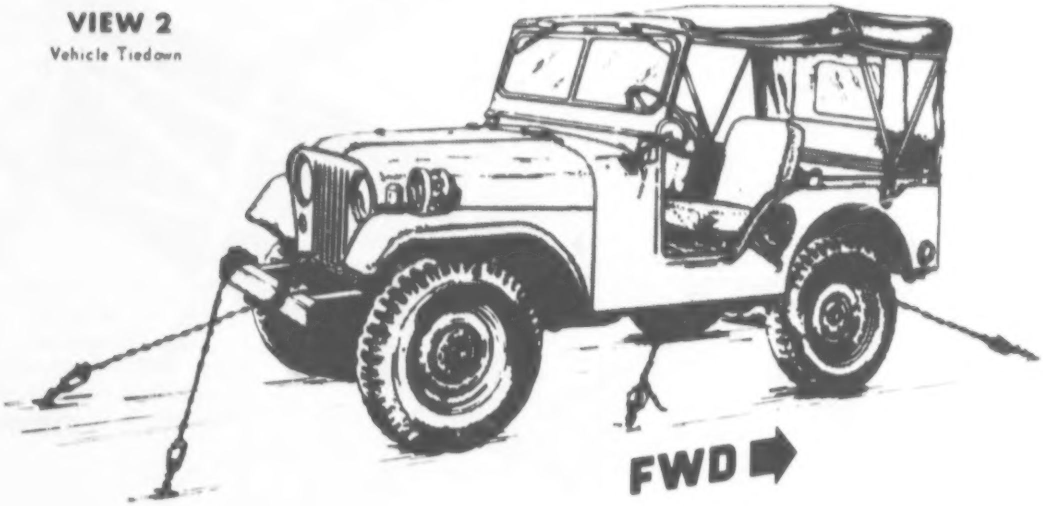
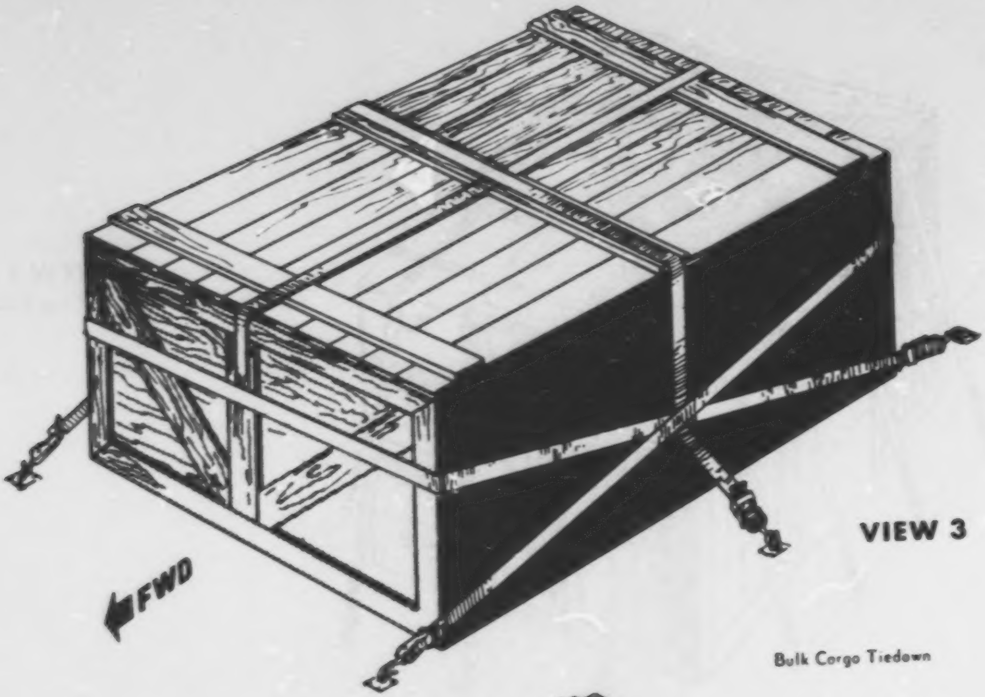
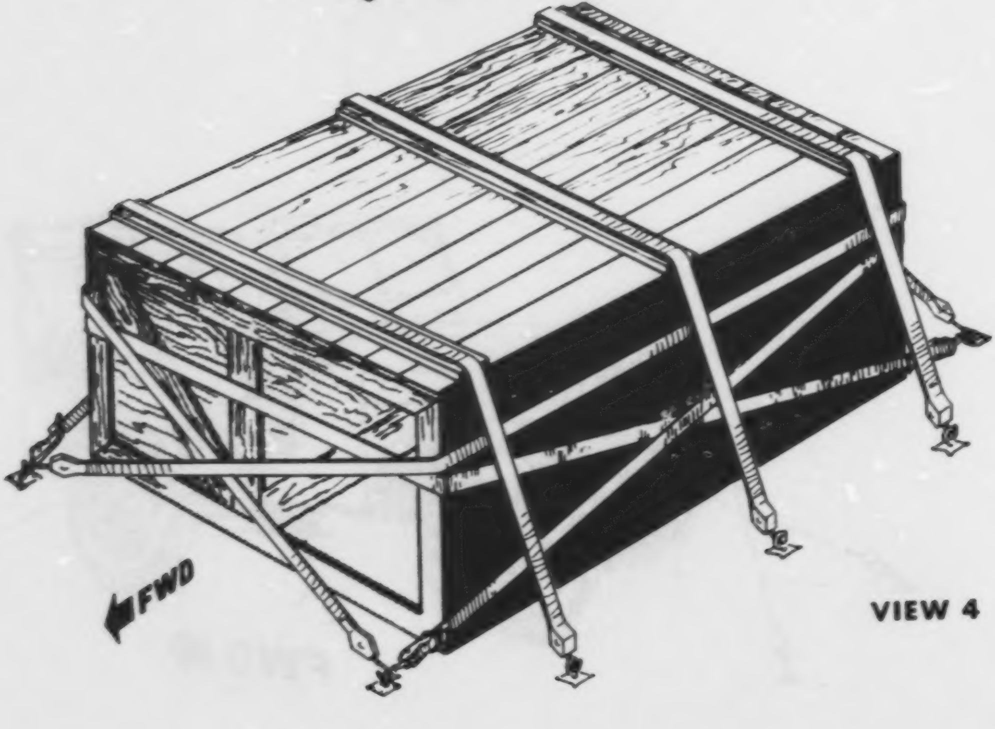


Figure 6-29. Typical Tiedown Methods (Sheet 1 of 2)



VIEW 3

Bulk Cargo Tiedown



VIEW 4

Figure 6-29. Typical Tiedown Methods (Sheet 2 of 2)

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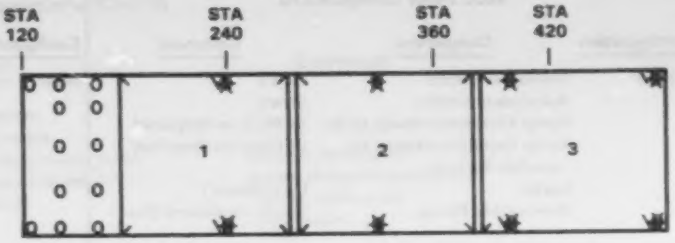
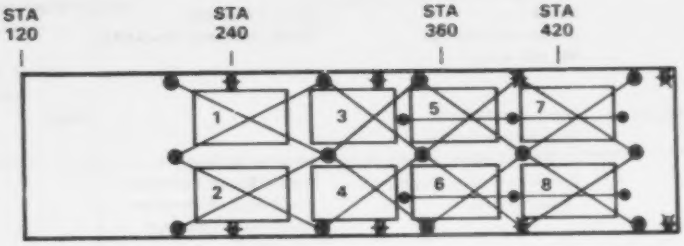
THREE USAF 463L PALLETS

CODE:
PALLETS 1 THRU 3 — 6,000 POUNDS EACH
\ LOCKING LOCATION
✱ 10,000-POUND TIEDOWN STRAP


STA 120
STA 240
STA 360
STA 420
1
2
3

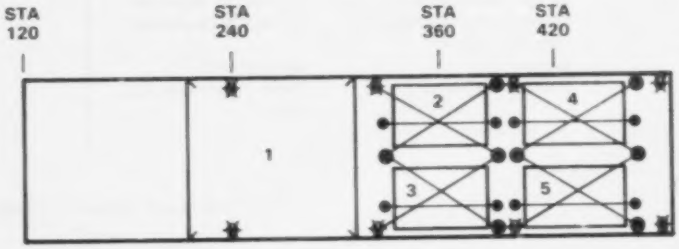
EIGHT STANDARD WAREHOUSE PALLETS

CODE:
PALLETS 1 THRU 8 — 1,500 POUNDS EACH
✱ 10,000-POUND TIEDOWN RING
● 5,000-POUND TIEDOWN RING
\ 5,000-POUND TIEDOWN STRAP


STA 120
STA 240
STA 360
STA 420
1
3
5
7
2
4
6
8

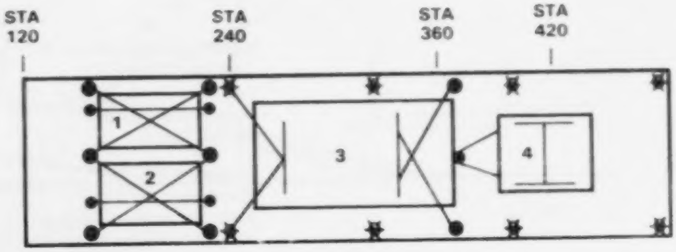
ONE USAF 463L PALLET WITH FOUR WAREHOUSE PALLETS

CODE:
PALLET 1 — 3,000 POUNDS
PALLET 2 — 1,775 POUNDS
PALLET 3 — 1,500 POUNDS
PALLET 4 — 1,000 POUNDS
PALLET 5 — 500 POUNDS
\ LOCKING LOCATION
✱ 10,000-POUND TIEDOWN RING
● 5,000-POUND TIEDOWN RING
\ 5,000-POUND TIEDOWN STRAP


STA 120
STA 240
STA 360
STA 420
1
2
4
3
5

JEEP WITH TRAILER AND TWO WAREHOUSE PALLETS

CODE:
PALLETS 1 AND 2 — 1,500 POUNDS EACH
PALLET 3 — 2,450 POUNDS
PALLET 4 — 580 POUNDS
✱ 10,000-POUND TIEDOWN RING
● 5,000-POUND TIEDOWN RING
\ 5,000-POUND TIEDOWN STRAP


STA 120
STA 240
STA 360
STA 420
1
2
3
4

13943

Figure 6-29.1 HICHS Cargo Combination

Table 6-2. Loading Sequence Configuration

463L Pallet Configurations

Configuration	Component	Comment
Load	Outboard Rollers	Down
	Warehouse Guides	Down
	Ramp Extension/Ramp Jacks	In Place as Required
	Ramp Extension/Ramp Extension Rollers	In Place as Required
	Locks	Up (Unlock)
	Retractable Flange	Rotate Outboard (Unlock)
	5k/10k Rings	Down (Stowed Position)
Restraint	Outboard Rollers	—
	Warehouse Guides	—
	Ramp Extension/Ramp Jacks	—
	Ramp Extension/Ramp Extension Rollers	—
	Locks	Down (Locked)
	Retractable Flange	Rotate Inboard (Locked)
	5k/10k Rings	—
Flight	Outboard Rollers	—
	Warehouse Guides	—
	Ramp Extension/Ramp Jacks	Stow in Helicopter
	Ramp Extension/Ramp Extension Rollers	Rotate Ramp Extension on Ramp, Rollers on Underside (Stowed Position)
	Locks	—
	Retractable Flange	—
	5k/10k Rings	—
Unload	Outboard Rollers	—
	Warehouse Guides	—
	Ramp Extension/Ramp Jacks	In Place as Required
	Ramp Extension/Ramp Extension Rollers	In Place as Required
	Locks	Up (Unlock)
	Retractable Flange	Rotate Outboard (Unlock)
	5k/10k Rings	—

Warehouse Pallet Configurations

Configuration	Component	Comment
Load	Outboard Rollers	Down
	Warehouse Guides	Up
	Ramp Extension/Ramp Jacks	In Place as Required
	Ramp Extension/Ramp Extension Rollers	In Place as Required
	Locks	Down (Locked)
	Retractable Flange	Rotate Outboad (Unlock)
	5K/10k Rings	Up
Restraint	Outboard Rollers	—
	Warehouse Guides	—
	Ramp Extension/Ramp Jacks	—
	Ramp Extension/Ramp Extension Rollers	—
	Locks	—
	Retractable Flange	—
	5/10k Rings	Using Straps, Secure Cargo to 5/10k Rings
Flight	Outboard Rollers	—
	Warehouse Guides	—
	Ramp Extension/Ramp Jacks	Stow in Aircraft
	Ramp Extension/Ramp Extension Rollers	Rotate Ramp Extension on Ramp, Rollers on Underside
	Locks	—
	Retractable Flange	—
	5k/10k	—
Unload	Outboard Rollers	—
	Warehouse Guides	—
	Ramp Extension/Ramp Jacks	In Place as Required
	Ramp Extension/Ramp Extension Rollers	In Place as Required
	Locks	—
	Retractable Flange	—
	5k/10k Rings	—

Wheeled Vehicle Configurations

Configuration	Component	Comment
Load	Outboard Rollers*	Up - Straps on Cabin, Ramp Up
	Warehouse Guides	Down
	Ramp Extension/Ramp Jacks	No Ramp Extension Jacks, No Ramp Jack (Ramp on Ground)
	Ramp Extension/Ramp Extension Rollers	Ramp Extension on ground, No Rollers
	Locks	Down (Locked)
	Retractable Flange	Rotate Outboard (Unlock)
	5k/10k Rings	Up
Restraint	Outboard Rollers	—
	Warehouse Guides	—
	Ramp Extension/Ramp Jacks	—
	Ramp Extension/Ramp Extension Rollers	—
	Locks	—
	Retractable Flange	—
	5k/10k Rings	Using Straps and/or Chains, Secure Cargo to 5k/10k Rings

---

*Maximum available width with outboard rollers in stowed position is 85 inches lateral width.

Table 6-2. Loading Sequence Configuration (Cont'd)

Wheeled Vehicle Configurations (Cont'd)

Configuration	Component	Comment
Flight	Outboard Rollers	—
	Warehouse Guides	—
	Ramp Extension/Ramp Jacks	Stow in Helicopter
	Ramp Extension/Ramp Extension Rollers	Rotate Ramp Extension on Ramp, Rollers on Underside
	Locks	—
	Retractable Flange	—
	5k/10k Rings	—
Unload	Outboard Rollers	—
	Warehouse Guides	—
	Ramp Extension/Ramp Jacks	Ramp on Ground
	Ramp Extension/Ramp Extension Rollers	Ramp Extension on Ground
	Locks	—
	Retractable Flange	—
	5k/10k Rings	

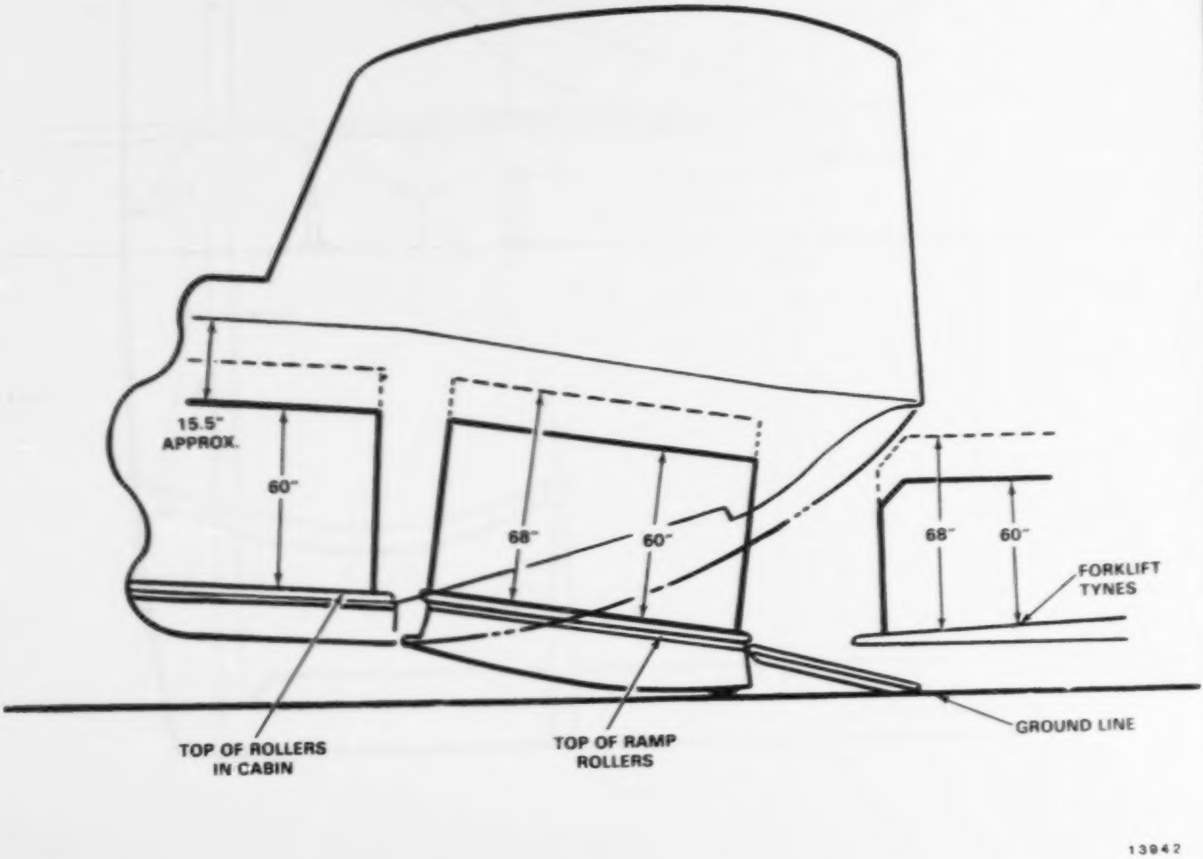
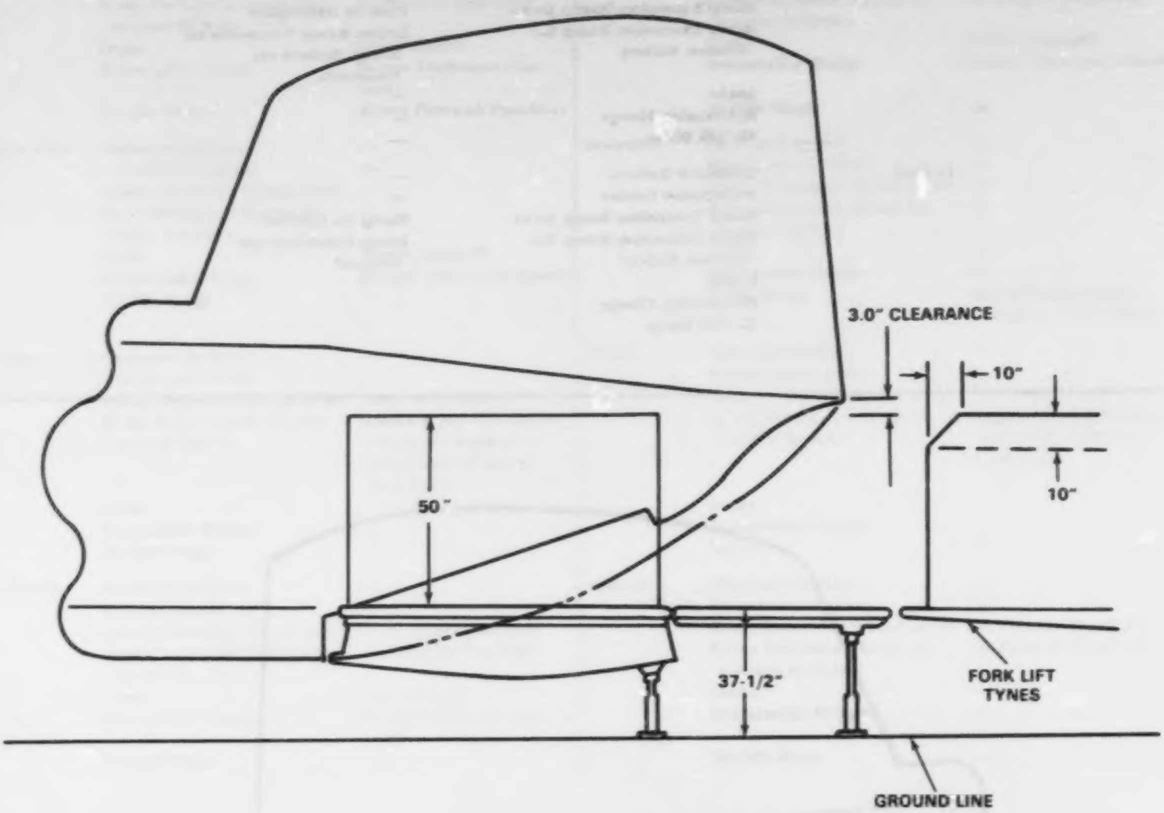

15.5"
APPROX.
60"
68"
60"
68"
60"
FORKLIFT
TYNES
TOP OF ROLLERS
IN CABIN
TOP OF RAMP
ROLLERS
GROUND LINE
13942

Figure 6-29.2 Loading with Ramp Down (Forklift Loading)


3.0" CLEARANCE
10"
10"
50"
37-1/2"
FORK LIFT TYNES
GROUND LINE

13941

Figure 6-29.3 Loading with Ramp in Level Position

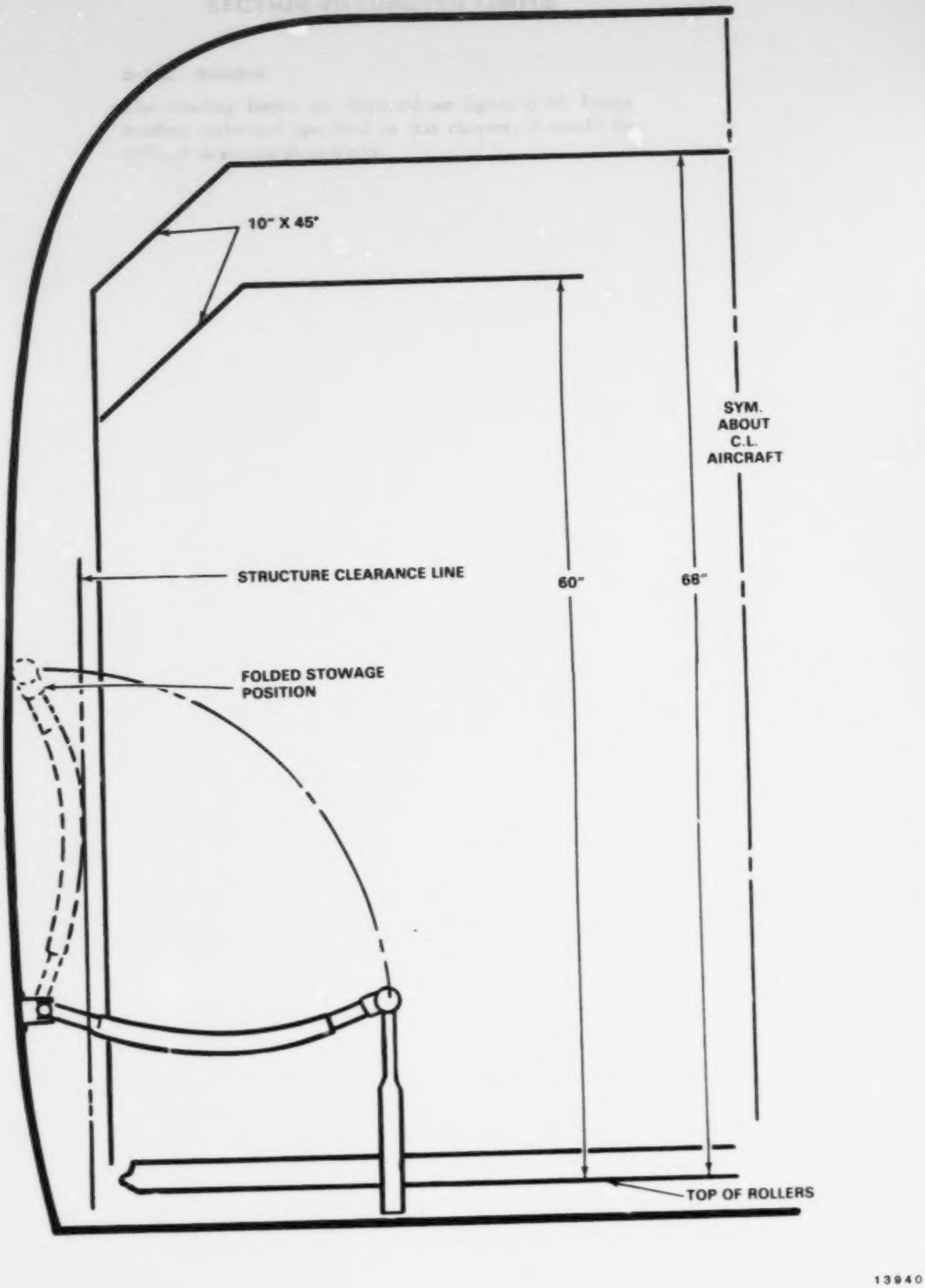

10" X 45°
SYM.
ABOUT
C.L.
AIRCRAFT
STRUCTURE CLEARANCE LINE
60"
68"
FOLDED STOWAGE
POSITION
TOP OF ROLLERS
13940

Figure 6-29.4 Load Clearances

SECTION VII LOADING LIMITS

6-102. General.

The loading limits are depicted on figure 6-30. Using loading technique specified in this chapter, it would be difficult to exceed these limits.

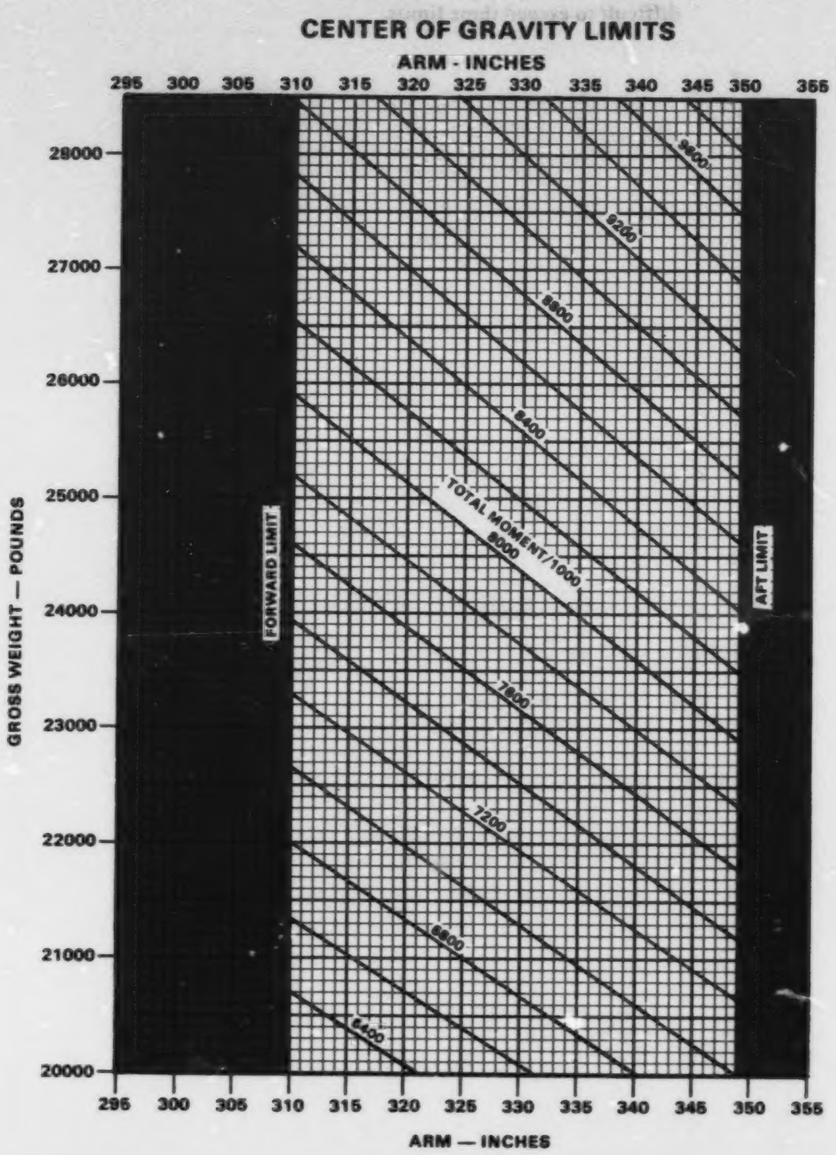


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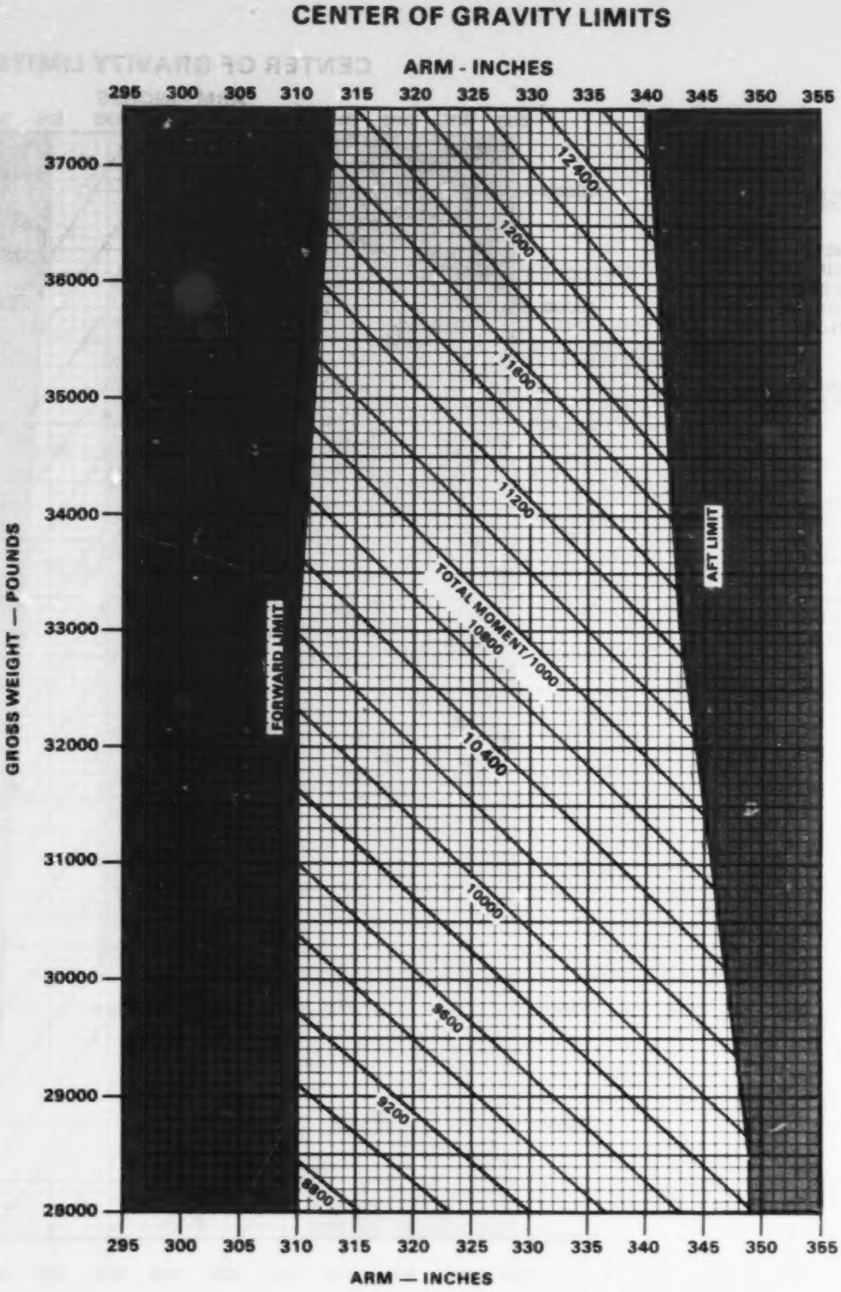
Figure 6-30. CG Limits Chart (Sheet 1 of 4)



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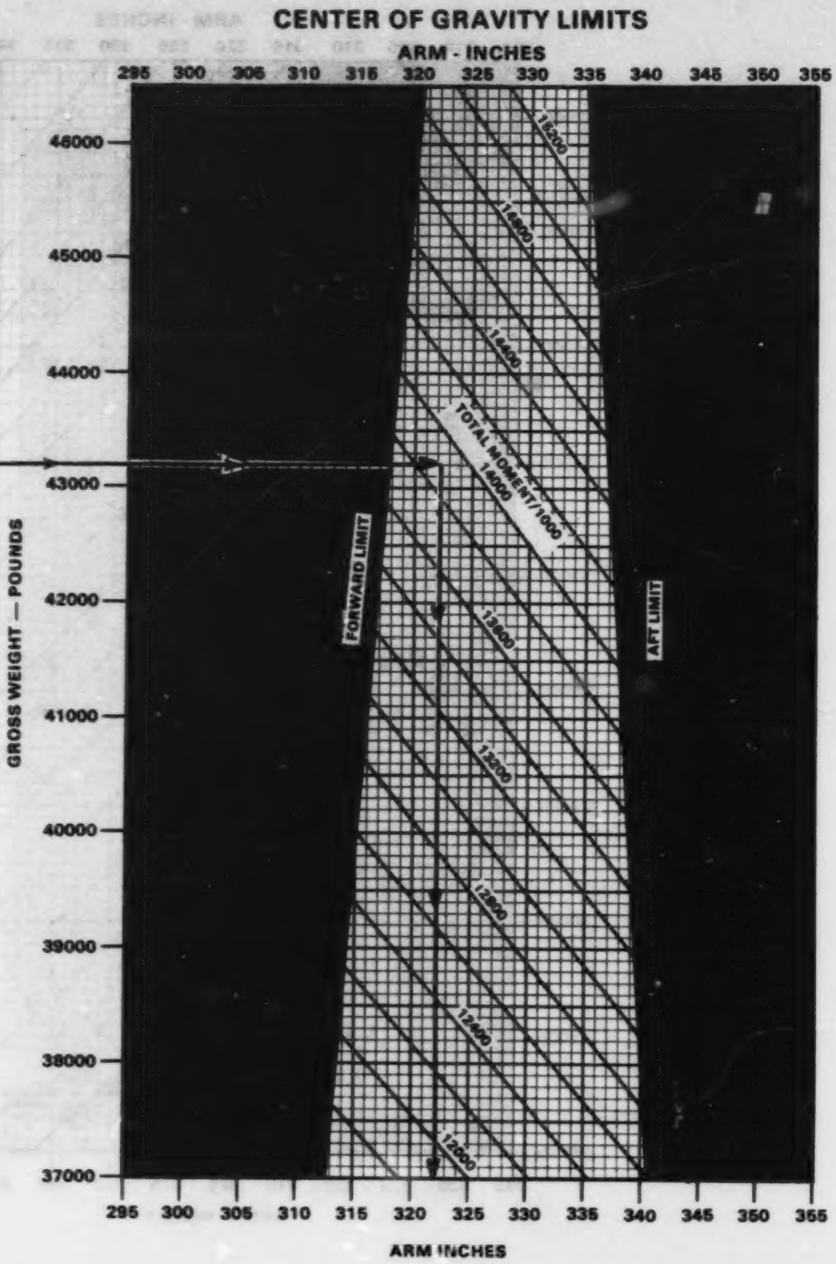
D145-102-10(2)

Figure 6-30. CG Limits Chart (Sheet 2 of 4)



EXAMPLE

WANTED
DETERMINE IF LOADING LIMITS ARE EXCEEDED AND DETERMINE C.G. POSITION

KNOWN
GW = 43200 LBS
MOMENT/1000 = 13900

METHOD
ENTER GROSS WEIGHT HERE MOVE RIGHT TO TOTAL MOMENT= 13900. READ LOAD WITHIN LIMITS MOVE DOWN READ ARM = 321.8

G
R

D145-102-10(3)

Figure 6-30. CG Limits Chart (Sheet 3 of 4)

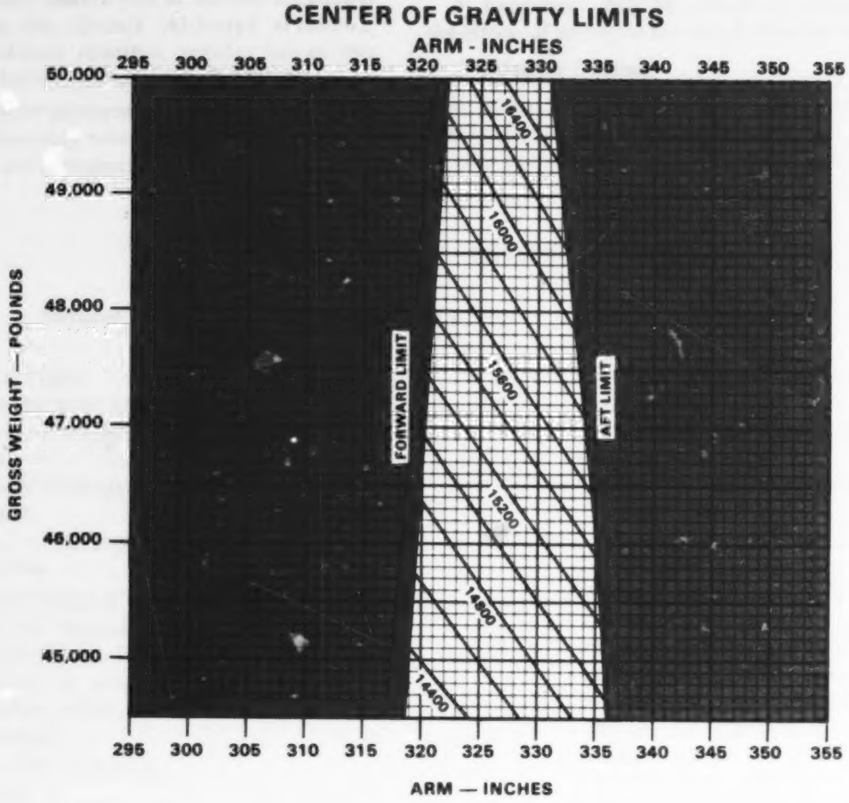


Figure 6-30. CG Limits Chart (Sheet 4 of 4)

CHAPTER 7

PERFORMANCE DATA

SECTION I INTRODUCTION

7-1. Purpose.

The purpose of this chapter is to provide the best available performance data for the CH-47D helicopter. Regular use of this information will enable you to receive maximum safe utilization from the aircraft. Although maximum performance is not always required, regular use of this chapter is recommended for the following reasons.

a. Knowledge of your performance margin will allow you to make better decisions when unexpected conditions or alternate missions are encountered.

b. Situations requiring maximum performance will be more readily recognized.

c. Familiarity with the data will allow performance to be computed more easily and quickly.

d. Experience will be gained in accurately estimating the effects of variables for which data are not presented.

7-2. Chapter 7 Index.

The following index contains a list of the sections and their titles, the figure numbers, subjects, and page numbers of each performance data chart contained in this chapter.

CHAPTER 7 INDEX

Section	Subject	Page
I	INTRODUCTION	7-1
II	PERFORMANCE PLANNING	7-4
	Figure 7-1. Temperature Conversion Chart	7-5
III	EMERGENCY TORQUE AVAILABLE	7-6
	Figure 7-2. Emergency Torque Available	7-7
IV	MAXIMUM TORQUE AVAILABLE	7-8
	Figure 7-3. Maximum Torque Available (10-Minute Operation)	7-9
	Figure 7-4. Maximum Torque Available (30-Minute Operation)	7-10
V	CONTINUOUS TORQUE AVAILABLE	7-12
	Figure 7-5. Continuous Torque Available	7-13
VI	HOVER	7-14
	Figure 7-6. Hover Chart	7-15
	Figure 7-7. Hover Ceiling	7-16
VII	TAKEOFF	7-18
	Figure 7-8. Takeoff Chart	7-19
VIII	CRUISE	7-21
	Figure 7-9. Example Cruise Chart	7-22
	Figure 7-10. 98 and 100% Rotor RPM, −50°C, Sea Level	7-24
	Figure 7-10.1. 98 and 100% Rotor RPM, −40°C, Sea Level	7-24.1
	Figure 7-10.2. 98 and 100% Rotor RPM, −30°C, Sea Level	7-24.2
	Figure 7-11. 98 and 100% Rotor RPM, −20°C, Sea Level	7-25
	Figure 7-12. 100% Rotor RPM, −10° and 0°C, Sea Level	7-26
	Figure 7-13. 100% Rotor RPM, 10° and 20°C, Sea Level	7-27
	Figure 7-14. 100% Rotor RPM, 30° and 40°C, Sea Level	7-28
	Figure 7-14.1. 100% Rotor RPM, 50°C, Sea Level	7-28.1
	Figure 7-15. 98 and 100% Rotor RPM, −50°C, 2,000 Feet	7-28.2
	Figure 7-15.1. 98 and 100% Rotor RPM, −40°C, 2,000 Feet	7-28.3
	Figure 7-15.2. 98 and 100% Rotor RPM, −30°C, 2,000 Feet	7-29
	Figure 7-16. 98 and 100% Rotor RPM, −20°C, 2,000 Feet	7-30
	Figure 7-17. 100% Rotor RPM, −10° and 0°C, 2,000 Feet	7-31
	Figure 7-18. 100% Rotor RPM, 10° and 20°C, 2,000 Feet	7-32
	Figure 7-19. 100% Rotor RPM, 30° and 40°C, 2,000 Feet	7-32.1
	Figure 7-19.1. 100% Rotor RPM, 50°C, 2,000 Feet	7-33
	Figure 7-20. 98 and 100% Rotor RPM, −50°C, 4,000 Feet	7-34
	Figure 7-20.1. 98 and 100% Rotor RPM, −40°C, 4,000 Feet	7-34.1
	Figure 7-20.2. 98 and 100% Rotor RPM, −30°C, 4,000 Feet	7-34.2
	Figure 7-21. 98 and 100% Rotor RPM, −20°C, 4,000 Feet	7-35
	Figure 7-22. 100% Rotor RPM, −10° and 0°C, 4,000 Feet	7-36

CHAPTER 7 INDEX (Continued)

Section Subject Page

Figure 7-23. 100% Rotor RPM, 10° and 20°C, 4,000 Feet 7-37
Figure 7-24. 100% Rotor RPM, 30° and 40°C, 4,000 Feet 7-38
Figure 7-24.1. 100% Rotor RPM, 50°C, 4,000 Feet 7-38.1
Figure 7-25. 98 and 100% Rotor RPM, -50°C, 6,000 Feet 7-38.2
Figure 7-25.1. 98 and 100% Rotor RPM, -40°C, 6,000 Feet 7-38.3
Figure 7-25.2. 98 and 100% Rotor RPM, -30°C, 6,000 Feet 7-39
Figure 7-26. 98 and 100% Rotor RPM, -20°C, 6,000 Feet 7-40
Figure 7-27. 100% Rotor RPM, -10° and 0°C, 6,000 Feet 7-41
Figure 7-28. 100% Rotor RPM, 10° and 20°C, 6,000 Feet 7-42
Figure 7-29. 100% Rotor RPM, 30° and 40°C, 6,000 Feet 7-43
Figure 7-29.1. 100% Rotor RPM, 50°C, 6,000 Feet 7-44
Figure 7-30. 98 and 100% Rotor RPM, -50°C, 8,000 Feet 7-44.1
Figure 7-30.1. 98 and 100% Rotor RPM, -40°C, 8,000 Feet 7-44.2
Figure 7-30.2. 98 and 100% Rotor RPM, -30°C, 8,000 Feet 7-44.3
Figure 7-31. 98 and 100% Rotor RPM, -20°C, 8,000 Feet 7-45
Figure 7-32. 100% Rotor RPM, -10° and 0°C, 8,000 Feet 7-46
Figure 7-33. 100% Rotor RPM, 10° and 20°C, 8,000 Feet 7-47
Figure 7-34. 100% Rotor RPM, 30° and 40°C, 8,000 Feet 7-48
Figure 7-34.1. 100% Rotor RPM, 50°C, 8,000 Feet 7-48.1
Figure 7-35. 98 and 100% Rotor RPM, -50°C, 10,000 Feet 7-48.2
Figure 7-35.1. 98 and 100% Rotor RPM, -40°C, 10,000 Feet 7-48.3
Figure 7-35.2. 98 and 100% Rotor RPM, -30°C, 10,000 Feet 7-49
Figure 7-36. 98 and 100% Rotor RPM, -20°C, 10,000 Feet 7-50
Figure 7-37. 100% Rotor RPM, -10° and 0°C, 10,000 Feet 7-51
Figure 7-38. 100% Rotor RPM, 10° and 20°C, 10,000 Feet 7-52
Figure 7-39. 100% Rotor RPM, 30° and 40°C, 10,000 Feet 7-53
Figure 7-39.1. 100% Rotor RPM, 50°C, 10,000 Feet 7-54
Figure 7-40. 98 and 100% Rotor RPM, -50°C, 12,000 Feet 7-54.1
Figure 7-40.1. 98 and 100% Rotor RPM, -40°C, 12,000 Feet 7-54.2
Figure 7-40.2. 98 and 100% Rotor RPM, -30°C, 12,000 Feet 7-54.3
Figure 7-41. 98 and 100% Rotor RPM, -20°C, 12,000 Feet 7-55
Figure 7-42. 100% Rotor RPM, -10° and 0°C, 12,000 Feet 7-56
Figure 7-43. 100% Rotor RPM, 10° and 20°C, 12,000 Feet 7-57
Figure 7-44. 100% Rotor RPM, 30° and 40°C, 12,000 Feet 7-58
Figure 7-44.1. 100% Rotor RPM, 50°C, 12,000 Feet 7-58.1
Figure 7-45. 98 and 100% Rotor RPM, -50°C, 14,000 Feet 7-58.2
Figure 7-45.1. 98 and 100% Rotor RPM, -40°C, 14,000 Feet 7-58.3
Figure 7-45.2. 98 and 100% Rotor RPM, -30°C, 14,000 Feet 7-59
Figure 7-46. 98 and 100% Rotor RPM, -20°C, 14,000 Feet 7-60
Figure 7-47. 100% Rotor RPM, -10° and 0°C, 14,000 Feet 7-61
Figure 7-48. 100% Rotor RPM, 10° and 20°C, 14,000 Feet 7-62
Figure 7-49. 100% Rotor RPM, 30° and 40°C, 14,000 Feet 7-63
Figure 7-49.1. 100% Rotor RPM, 50°C, 14,000 Feet 7-64
Figure 7-50. 98 and 100% Rotor RPM, -50°C, 16,000 Feet 7-64.1
Figure 7-50.1. 98 and 100% Rotor RPM, -40°C, 16,000 Feet 7-64.2
Figure 7-50.2. 98 and 100% Rotor RPM, -30°C, 16,000 Feet 7-64.3
Figure 7-51. 98 and 100% Rotor RPM, -20°C, 16,000 Feet 7-65
Figure 7-52. 100% Rotor RPM, -10° and 0°C, 16,000 Feet 7-66
Figure 7-53. 100% Rotor RPM, 10° and 20°C, 16,000 Feet 7-67
Figure 7-54. 100% Rotor RPM, 30° and 40°C, 16,000 Feet 7-68
Figure 7-54.1. Deleted
Figure 7-55. 98 and 100% Rotor RPM, -50°C, 18,000 Feet 7-68.2
Figure 7-55.1. 98 and 100% Rotor RPM, -40°C, 18,000 Feet 7-68.3
Figure 7-55.2. 98 and 100% Rotor RPM, -30°C, 18,000 Feet 7-69
Figure 7-56. 98 and 100% Rotor RPM, -20°C, 18,000 Feet 7-70
Figure 7-57. 100% Rotor RPM, -10° and 0°C, 18,000 Feet 7-71
Figure 7-58. 100% Rotor RPM, 10° and 20°C, 18,000 Feet 7-72
Figure 7-59. 100% Rotor RPM, 30° and 40°C, 18,000 Feet 7-72.1

CHAPTER 7 INDEX (Continued)

Section	Subject	Page
	Figure 7-60. 98 and 100% Rotor RPM, –50°C, 20,000 Feet	7-72.2
	Figure 7-60.1. 98 and 100% Rotor RPM, –40°C, 20,000 Feet	7-73
	Figure 7-60.2. 98 and 100% Rotor RPM, –30°C, 20,000 Feet	7-74
	Figure 7-61. 98 and 100% Rotor RPM, –20°C, 20,000 Feet	7-75
	Figure 7-62. 100% Rotor RPM, –10° and 0°C, 20,000 Feet	7-76
	Figure 7-63. 100% Rotor RPM, 10° and 20°C, 20,000 Feet	7-77
IX	DRAG	7-78
	Figure 7-64. Drag Chart	7-79
X	CLIMB-DESCENT	7-80
	Figure 7-65. Climb-Descent Chart	7-81
	Figure 7-66. Climb Performance	7-82
XI	FUEL FLOW	7-83
	Figure 7-67. Idle Fuel Flow Chart	7-84
	Figure 7-68. Single Engine Fuel Flow Chart	7-85
XII	AIRSPEED CALIBRATION	7-86
	Figure 7-69. Airspeed Calibration Chart	7-87
XIII	ACCUMULATOR PRECHARGE LIMITS	7-88
	Figure 7-70. Flight Control, Utility System, Power Steering, and Signal Accumulators Precharge Limits	7-88
	Figure 7-71. Apu Start Accumulator Precharge Limits	7-91

7-3 General Data.

The data presented covers the maximum range of conditions and performance that can reasonably be expected. In each area of performance, the effects of altitude, temperature, gross weight, and other parameters relating to that phase of flight are presented. In addition to the presented data, your judgment and experience will be necessary to accurately obtain performance under a given set of circumstances. The conditions for the data are listed under the title of each chart. The effects of different conditions are discussed in the text accompanying each phase of performance.

Where practical, data are presented at conservative conditions. However, NO GENERAL CONSERVATISM HAS BEEN APPLIED. All performance data presented are within the applicable limits of the aircraft.

CAUTION

Exceeding operating limits can cause permanent damage to critical components. Over limit operation can decrease performance, cause immediate failure, or failure on a subsequent flight.

7-4. Limits.

Applicable limits are shown on the charts as red lines. The red dashed lines on the cruise charts in Section VIII are estimated airspeed limits with an operating cruise guide indicator. Airspeed limits with the cruise guide indicator inoperative are in Chapter 5. If limits are exceeded, minimize the degree and time.

7-5. Use of Charts.

a. Chart Explanation. The first page of each section describes the chart(s) and explains its use.

b. The primary use of each chart is given in an example and a green guideline is provided to help you follow the route through the chart. The use of a straight edge (ruler or page edge) and a hard fine point pencil is recommended to avoid cumulative errors. The majority of the charts provide a standard pattern for use as follows: enter first variable on top left scale, move right to the second variable, deflect down at right angles to the third variable, deflect left at right angles to the fourth variable, deflect down, etc. until the final variable is read out at the final scale. In addition to the primary use, other uses of each chart are explained in the text accompanying each set of performance charts. Colored registration blocks located on the bottom and top of each chart are used to determine if slippage has occurred during printing. If slippage has occurred, refer to Chapter 5 for correct operating limits.

NOTE

An example of an auxiliary use of the charts referenced above is as follows: Although the hover chart is primarily arranged to find torque required to hover, by entering torque available as torque required, maximum wheel height for hover can also be found. In general, any single variable can be found if all others are known. Also, the tradeoffs between variables can be found. For example, at a given density altitude and pressure altitude, you can find the maximum gross weight capability as free air temperature changes.

c. Dashed Line Data. Data beyond conditions for which tests were conducted, or for which estimates are used, are shown as dashed lines.

7-6. Data Basis.

The type of data used is indicated at the bottom of each performance chart under DATA BASIS. The applicable report and date of the data are also given. The data provided generally is based on one of the following categories.

a. Flight Test Data. Data obtained by flight test of the aircraft by experienced flight test personnel at precise conditions using sensitive calibrated instruments.

b. Calculated Data. Data based on tests, but not on flight test of the complete aircraft.

c. Estimated Data. Data based on estimates using aerodynamic theory or other means but not verified by flight test.

7-7. Specific Conditions.

The data presented are accurate only for specific conditions listed under the title of each chart. Variables for which data are not presented, but which may affect that phase of performance, are discussed in the text. Where data are available or reasonable estimates can be made, the amount that each variable affects performance will be given.

7-8. General Conditions.

In addition to the specific conditions, the following general conditions are applicable to the performance data.

a. Rigging. All airframe and engine controls are assumed to be rigged within allowable tolerances.

b. Pilot Technique. Normal pilot technique is assumed. Control movements should be smooth and continuous.

c. Aircraft Variation. Variations in performance between individual aircraft are known to exist; however, they are considered to be small and cannot be accounted for individually.

d. Instrument Variations. The data shown in the performance charts do not allow for instrument inaccuracies or malfunctions.

e. Airspeed Calibrations. The airspeed calibration chart presents the difference between indicated and calibrated airspeeds for different flight conditions.

f. Except as noted, all data is for a clean configuration (all doors installed, without armament).

7-9. Performance Discrepancies.

Regular use of this chapter will allow you to monitor instruments and other aircraft systems for malfunction, by comparing actual performance with planned performance. Knowledge will also be gained concerning the effects of variables for which data are not provided, thereby increasing the accuracy of performance predictions.

7-10. Definitions of Abbreviations.

a. Capitalization and punctuation of abbreviations varies, depending upon the context in which they are used. In general, lower case abbreviations are used in text material, whereas abbreviations used in charts and illustrations appear in full capital letters. Periods do not usually follow abbreviations; however, periods are used with abbreviations that could be mistaken for whole words if the period were omitted.

b. The following list provides definitions for abbreviations used in this chapter. Abbreviations used elsewhere in this manual are found in Appendix B of this manual. The same abbreviation applies for either singular or plural applications.

SECTION II PERFORMANCE PLANNING

List of Abbreviations

Abbreviations	*Definitions*
ALT	Altitude
AS	Airspeed
AVAIL	Available
C	Celsius
ENG	Engine
EXT	External
F	Fahrenheit
FAT	Free Air Temperature (figure 7-1)
FL	Flow
FPM	Feet Per Minute
FT	Feet
GR WT	Gross Weight
Hg	Mercury
HGT	Height
IAS	Indicated Airspeed
IGE	In Ground Effect
IN	Inch
KN	Knots
LB	Pound
LB-FT	Pound Feet
LB/HR	Pounds Per Hour
LG	Length

List of Abbreviations

Abbreviations	*Definitions*
LVL	Level
MAX	Maximum
MIL	Military
MIN	Minute, Minimum
N1	Gas Producer Speed
N2	Power Turbine Speed
OBST	Obstacle
OGE	Out of Ground Effect
PRESS	Pressure
R/C	Rate of Climb
R/D	Rate of Descent
RPM	Revolutions Per Minute
SL	Sea Level
SPEC	Specification
SQ FT	Square Feet
TAS	True Airspeed
TEMP	Temperature
TRQ	Torque
Vcgi	Estimated Airspeed Limit with an Operating Cruise Guide Indicator
Vne	Velocity Never Exceed
WT	Weight

TEMPERATURE CONVERSION CHART

EXAMPLE

WANTED

FAT IN DEGREES FAHRENHEIT °F

KNOWN

FAT = 20°C

METHOD

ENTER FAT (°C) HERE
MOVE RIGHT AND READ
FAT = 68°F

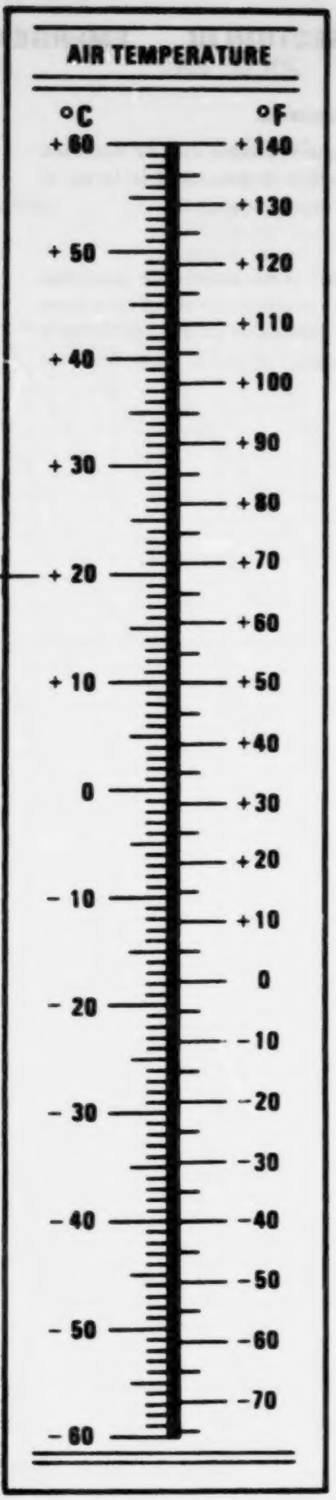


Figure 7-1. Temperature Conversion Chart

SECTION III EMERGENCY TORQUE AVAILABLE

7-11. Emergency Torque Available.

Single engine emergency torque available may be obtained from figure 7-2. Available torque is presented in terms of pressure altitude and free air temperature.

7-12. Use of Chart.

The primary use of the chart is to determine available engine torque for various combinations of pressure altitude and temperature. To determine torque available, it is necessary to know pressure altitude, and free air temperature. Enter the left side of the chart at known temperature, move right to known pressure altitude, then down to read torque available.

7-13. Conditions.

The chart is based on a rotor speed of 100% and engine anti-icing off. Bleed air is used during icing conditions (below 5°C), and the power loss associated with anti-ice bleed air operation is 7% at 5°C diminishing to 1% at −10°C (and below), at the rate of 1% per 2.5 degrees.

G ■
R ■

SINGLE ENGINE EMERGENCY TORQUE AVAILABLE
ENGINE ANTI-ICING OFF

100% ROTOR RPM **JP-4 FUEL** **TAS=0 KN**

EMERGENCY TORQUE
CH-47D
(2) T55-L-712

EXAMPLE

WANTED

EMERGENCY TORQUE AVAILABLE FOR SINGLE ENGINE OPERATION

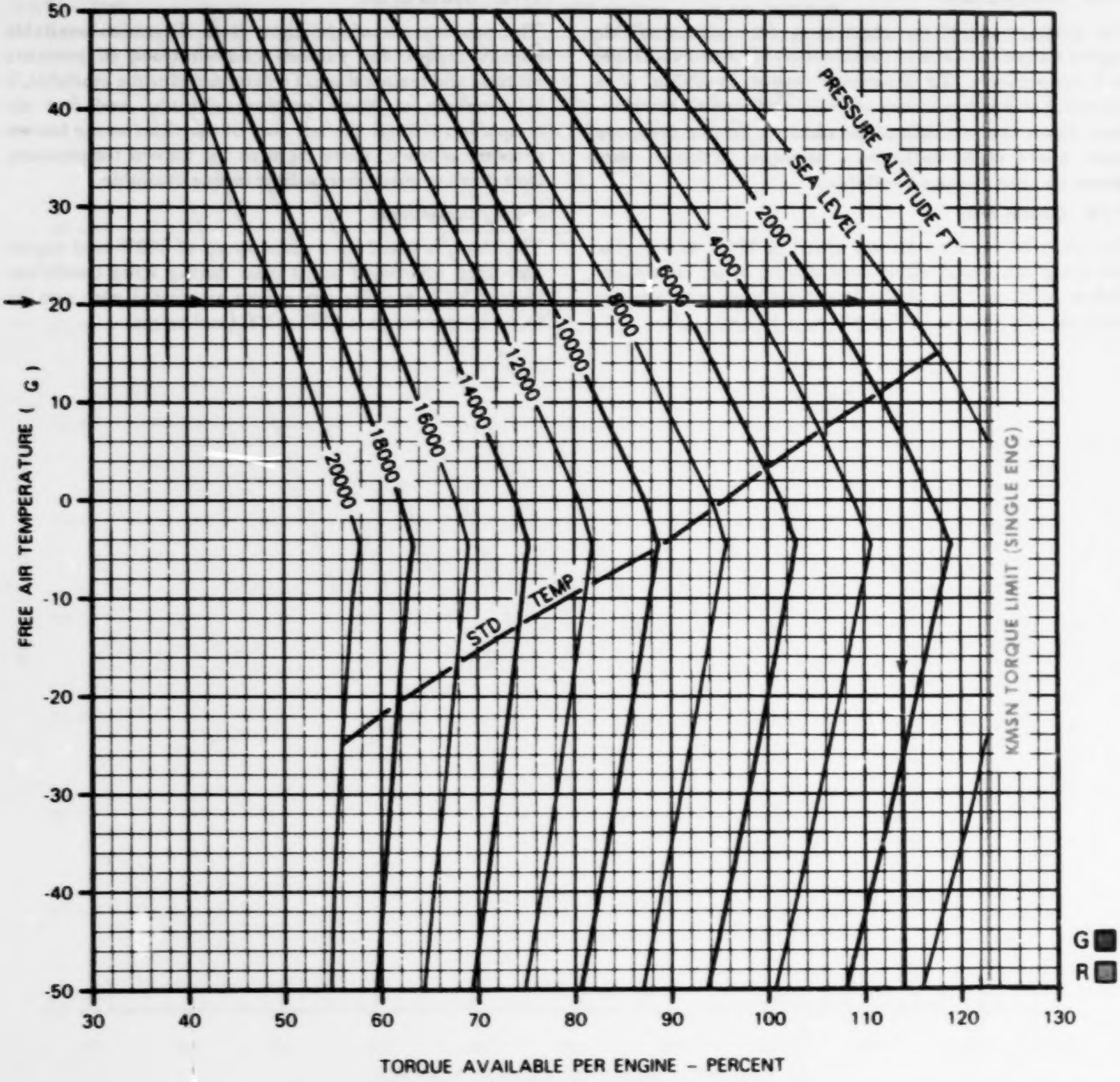
KNOWN

PRESSURE ALTITUDE = SEA LEVEL/FAT = 20°C

METHOD

SINGLE ENGINE OPERATION

ENTER FAT AT 20°C MOVE RIGHT TO
PRESSURE ALTITUDE = SEA LEVEL
MOVE DOWN TO READ EMERGENCY TORQUE
AVAILABLE PER ENGINE = 114.0 PERCENT



DATA BASIS: CALCULATED FROM MODEL SPEC 124.53(B) AND FLIGHT TEST

A9727

Figure 7-2. Emergency Torque Available

SECTION IV MAXIMUM TORQUE AVAILABLE

7-14. Maximum Torque Available (10-Minute Operation).

Maximum torque available (10-minute operation) may be obtained from figure 7-3. Available torque is presented in terms of pressure altitude and free air temperature.

7-15. *Use of Chart.*

The primary use of the chart is to determine available engine torque for various combination of pressure altitude and temperature. To determine torque available, it is necessary to know pressure altitude, and free air temperature. Enter the left side of the chart at known temperature, move right to known pressure altitude, then down to read torque available.

7-16. *Conditions.*

The chart is based on a rotor speed of 100% and engine anti-icing off. Bleed air is used during icing conditions (below 5°C), and the power loss associated with anti-ice bleed air operation is 11% at 5°C (and below).

7-17. Maximum Torque Available (30-Minute Operation).

Maximum torque available (30-minute operation) may be obtained from figure 7-4. Available torque is presented in terms of pressure altitude and free air temperature.

7-18. *Use of Chart.*

The primary use of the chart is to determine available engine torque for various combinations of pressure altitude and temperature. To determine torque available, it is necessary to know pressure altitude, and free air temperature. Enter the left side of the chart at the known pressure altitude, move right to the known temperature, then down to read intermediate torque available.

7-19. *Conditions.*

The chart is based on a rotor speed of 100% and engine anti-icing off. Bleed air is used during icing conditions (below 5°C), and the power loss associated with anti-ice bleed air operation is 12% at 5°C (and below).

■ G
■ R

MAXIMUM TORQUE AVAILABLE (10 MIN. OPERATION)

ENGINE ANTI-ICING OFF

MAXIMUM TORQUE
CH-47D
T55-L-712

100% ROTOR RPM **JP-4 FUEL** **TAS=0 KN**

EXAMPLE

WANTED

MAXIMUM TORQUE AVAILABLE FOR SINGLE AND DUAL ENGINE OPERATION

KNOWN

PRESSURE ALTITUDE = SEA LEVEL
/FAT = 20°C

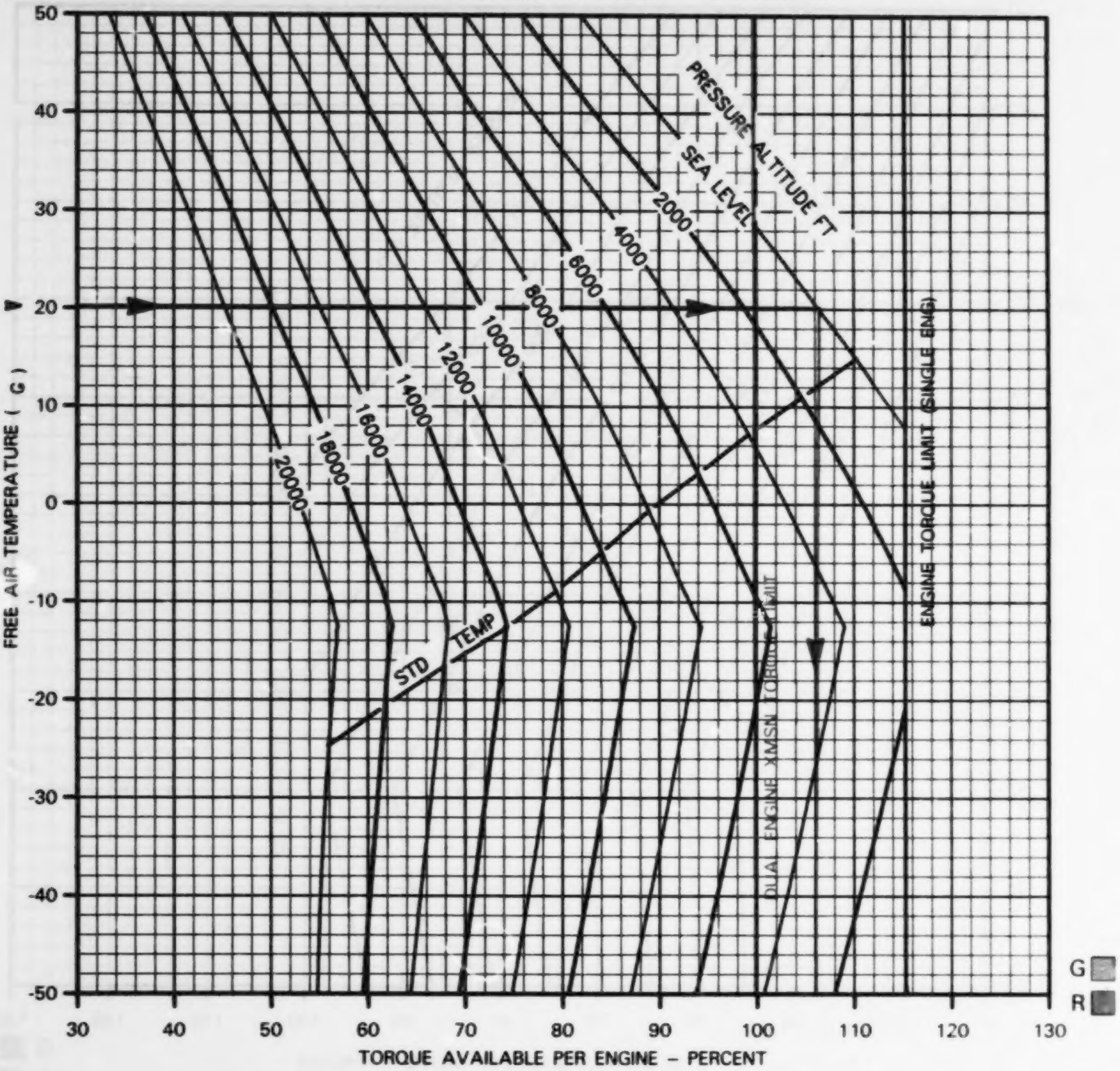
METHOD

SINGLE ENGINE OPERATION

ENTER FAT AT 20°C MOVE RIGHT TO PRESSURE ALTITUDE = SEA LEVEL MOVE DOWN READ MAXIMUM TORQUE AVAILABLE PER ENGINE = 106.0 PERCENT

DUAL ENGINE OPERATION

ENTER FAT AT 20°C MOVE RIGHT TO PRESSURE ALTITUDE = SEA LEVEL OR DUAL ENGINE XMSN. TORQUE LIMIT. MOVE DOWN READ MAXIMUM TORQ'JE AVAILABLE PER ENGINE = 100.0 PERCENT



DATA BASIS: CALCULATED FROM MODEL SPEC 124.53(B) AND FLIGHT TEST

A9728

Figure 7-3. Maximum Torque Available (10-Minute Operation)

■ G
■ R

MAXIMUM TORQUE AVAILABLE (30 MIN OPERATION)
ENGINE ANTI-ICING OFF

100% ROTOR RPM **JP-4 FUEL** **TAS=0 KN**

MAXIMUM TORQUE
CH-47D
T55-T-712

EXAMPLE

WANTED

MAXIMUM TORQUE AVAILABLE FOR SINGLE AND DUAL ENGINE OPERATION

KNOWN

PRESSURE ALTITUDE = SEA LEVEL/FAT = 20°C

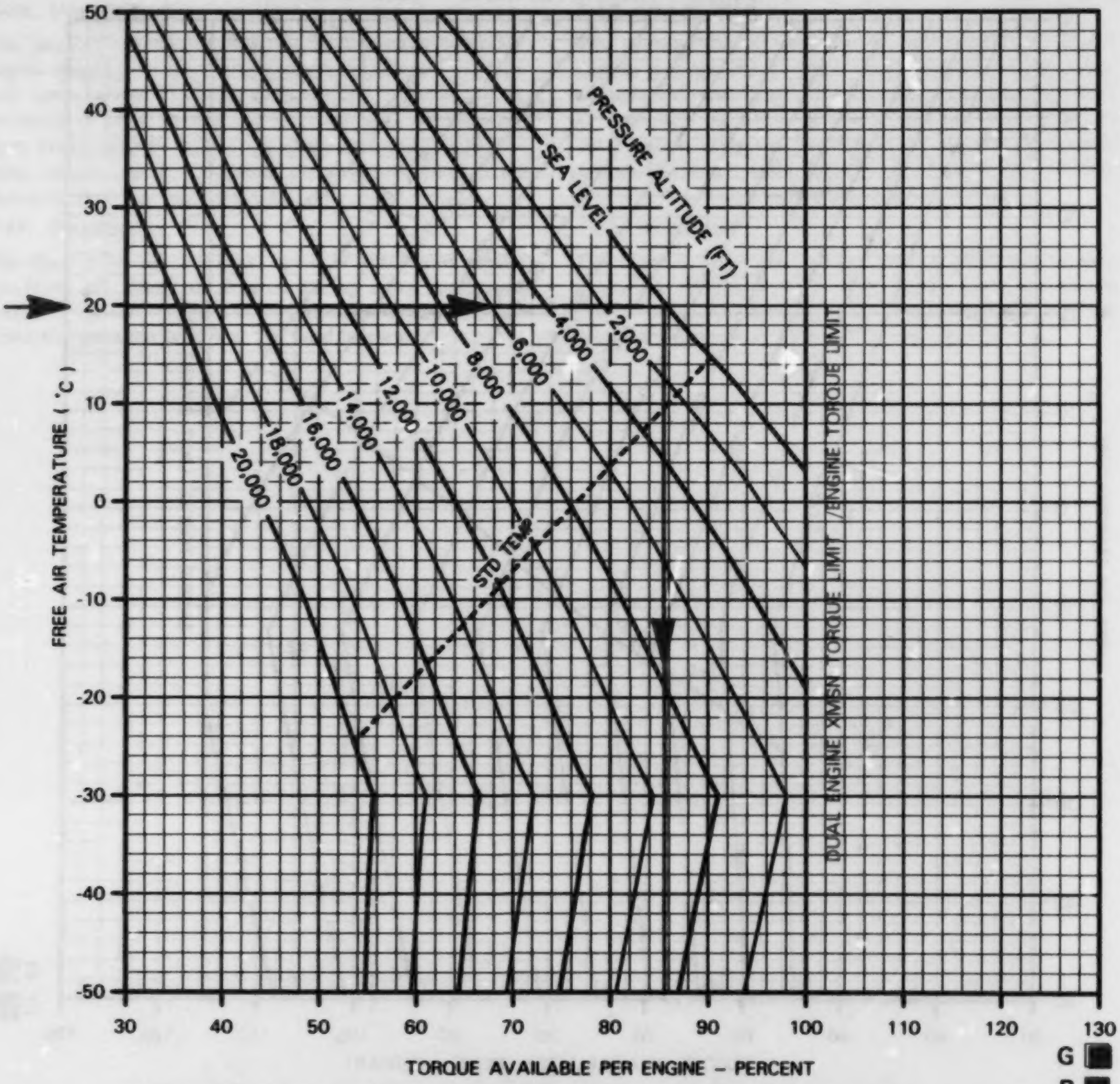
METHOD

SINGLE ENGINE OPERATION

ENTER FAT AT 20°C. MOVE RIGHT TO PRESSURE ALTITUDE = SEA LEVEL. MOVE DOWN, READ TORQUE AVAILABLE PER ENGINE = 85.4 PERCENT

DUAL ENGINE OPERATION

ENTER FAT AT 20°C. MOVE RIGHT TO PRESSURE ALTITUDE = SEA LEVEL. MOVE DOWN, READ MAXIMUM TORQUE AVAILABLE PER ENGINE = 85.4 PERCENT



■ G
■ R

DATA BASIS: CALCULATED FROM MODEL SPEC 124.53(B) AND FLIGHT TEST

A9729

Figure 7-4. Maximum Torque Available (30-Minute Operation)

SECTION V CONTINUOUS TORQUE AVAILABLE

7-20. Continuous Torque Available.

Continuous torque available may be obtained from figure 7-5. Available torque is presented in terms of pressure altitude and free air temperature.

7-21. Use of Chart.

The primary use of the charts is to determine available engine torque for various combinations of pressure altitude and temperature. To determine torque available, it is necessary to know pressure altitude and free air temperature. Enter the left side of the chart at known temperature, move right to known pressure altitude, then down to read torque available.

7-22. Conditions.

The chart is based on a rotor speed of 100% and engine anti-icing off. Bleed air is used during icing conditions (below 5°C), and the power loss associated with anti-ice bleed air operation is 12% at 5°C (and below).

■ G
■ R

CONTINUOUS TORQUE AVAILABLE
ENGINE ANTI-ICING OFF

CONTINUOUS TORQUE
CH-47D
(2) T55-L-712

100% ROTOR RPM **JP-4 FUEL** **TAS=0 KN**

EXAMPLE

WANTED

CONTINUOUS TORQUE AVAILABLE FOR SINGLE AND DUAL ENGINE OPERATION

KNOWN

PRESSURE ALTITUDE = SEA LEVEL/FAT = 20°C

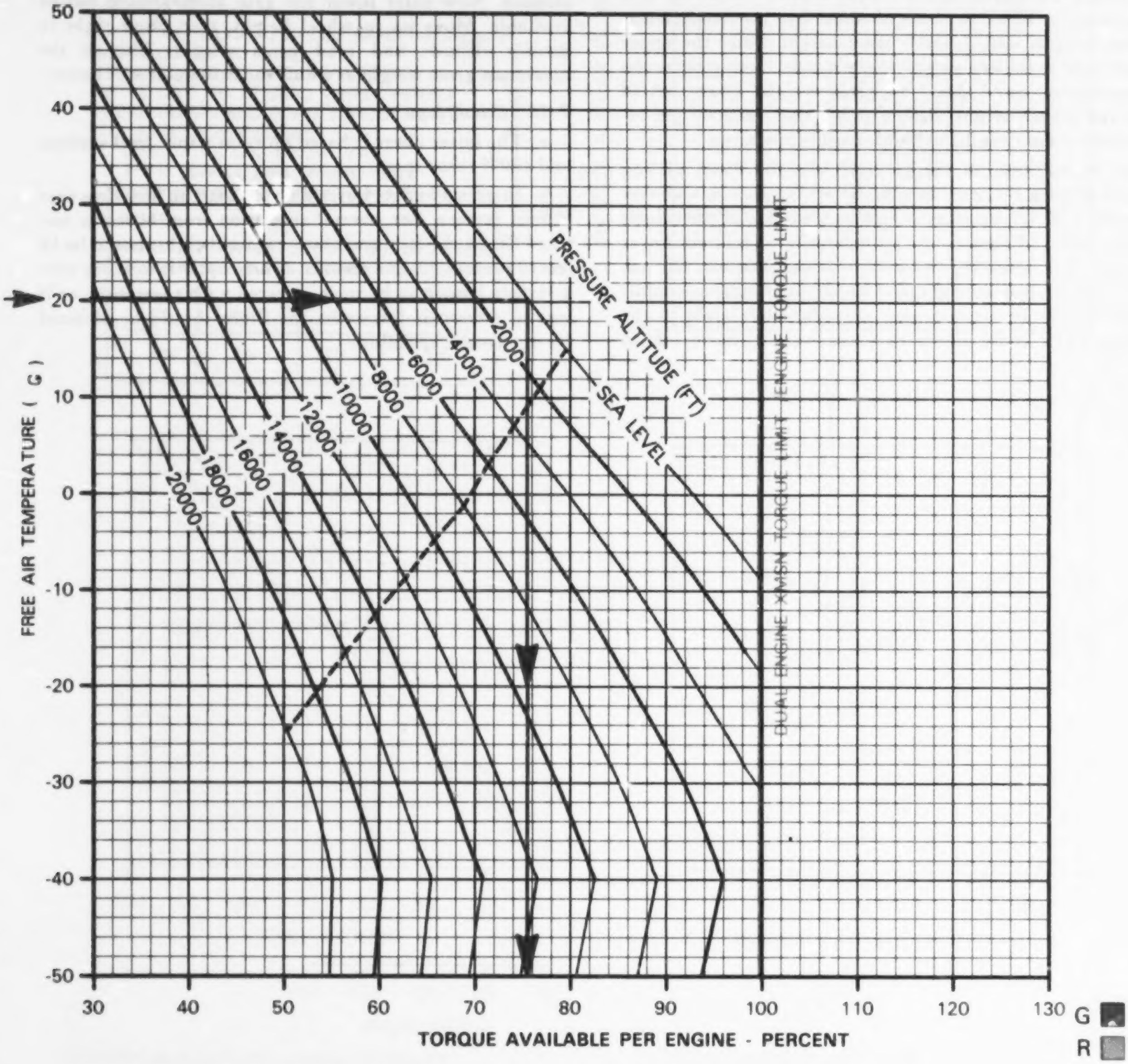
METHOD

SINGLE ENGINE OPERATION

ENTER FAT AT 20°C MOVE RIGHT TO PRESSURE ALTITUDE = SEA LEVEL MOVE DOWN READ CONTINUOUS TORQUE AVAILABLE PRE ENGINE = 75.7 PERCENT

DUAL ENGINE OPERATION

ENTER FAT AT 20°C MOVE RIGHT TO PRESSURE ALTITUDE = SEA LEVEL MOVE DOWN READ CONTINUOUS TORQUE AVAILABLE PRE ENGINE = 75.7 PERCENT



DATA BASIS: CALCULATED FROM MODEL SPEC 124.53(B) AND FLIGHT TEST

A9730

Figure 7-5. Continuous Torque Available

SECTION V: HOVER

7-23. DESCRIPTION.

The hover chart, figure 7-6, presents torque required to hover at 100% rotor rpm at various combinations of pressure altitude, free air temperature, gross weight, and wheel height for single and dual engine operation.

7-24. Use of Chart.

a. The primary use of the charts is illustrated by the example. To determine the torque required to hover, it is necessary to know pressure altitude, free air temperature, gross weight, and desired wheel height. Enter the upper right grid at the known pressure altitude, move right to the temperature, move down to gross weight. Move left to desired wheel height, deflect down and read torque required for dual engine or single engine operation.

b. In addition to the primary use, the hover ceiling charts (figure 7-7) may be used to predict maximum hover height. This information is necessary for use of the takeoff chart found in figure 7-8. To determine maximum hover height, it is necessary to know pressure altitude, free air temperature, gross weight, and maximum torque available. Enter at the known pressure altitude, move right to the temperature, move down to gross weight, move left to intersection with maximum torque available and read wheel height. This wheel height is the maximum hover height.

c. The hover charts may also be used to determine maximum gross weight for hover at a given wheel height, pressure altitude, and temperature. Enter at known pressure altitude, move right to the temperature, then move down to the bottom of the lower grid, and read density altitude. Now enter lower left grid at maximum torque available. Move up to wheel height, then move right to density altitude and read gross weight. This is the maximum gross weight at which the helicopter will hover.

7-25. Conditions.

a. The hover chart is based on calm wind, level surface, and 100% rotor rpm.

b. In ground effect hover data is based on hovering over a level surface. For normal transition from hover to forward flight, the minimum hover wheel height should be 10 feet to prevent ground contact. If helicopter is to hover over a surface known to be steep, covered with vegetation, or if type of terrain is unknown, the flight should be planned for oge hover capability.

G ■
R ■

HOVER

100% ROTOR RPM CALM WIND LEVEL SURFACE

HOVER
CH-47D
(2) T55-L-712

EXAMPLE

WANTED

TORQUE REQUIRED TO HOVER

KNOWN

PRESSURE ALTITUDE = 5000 FT/FAT = -10°C
GROSS WEIGHT = 38000LB
DESIRED WHEEL HEIGHT = 20 FT

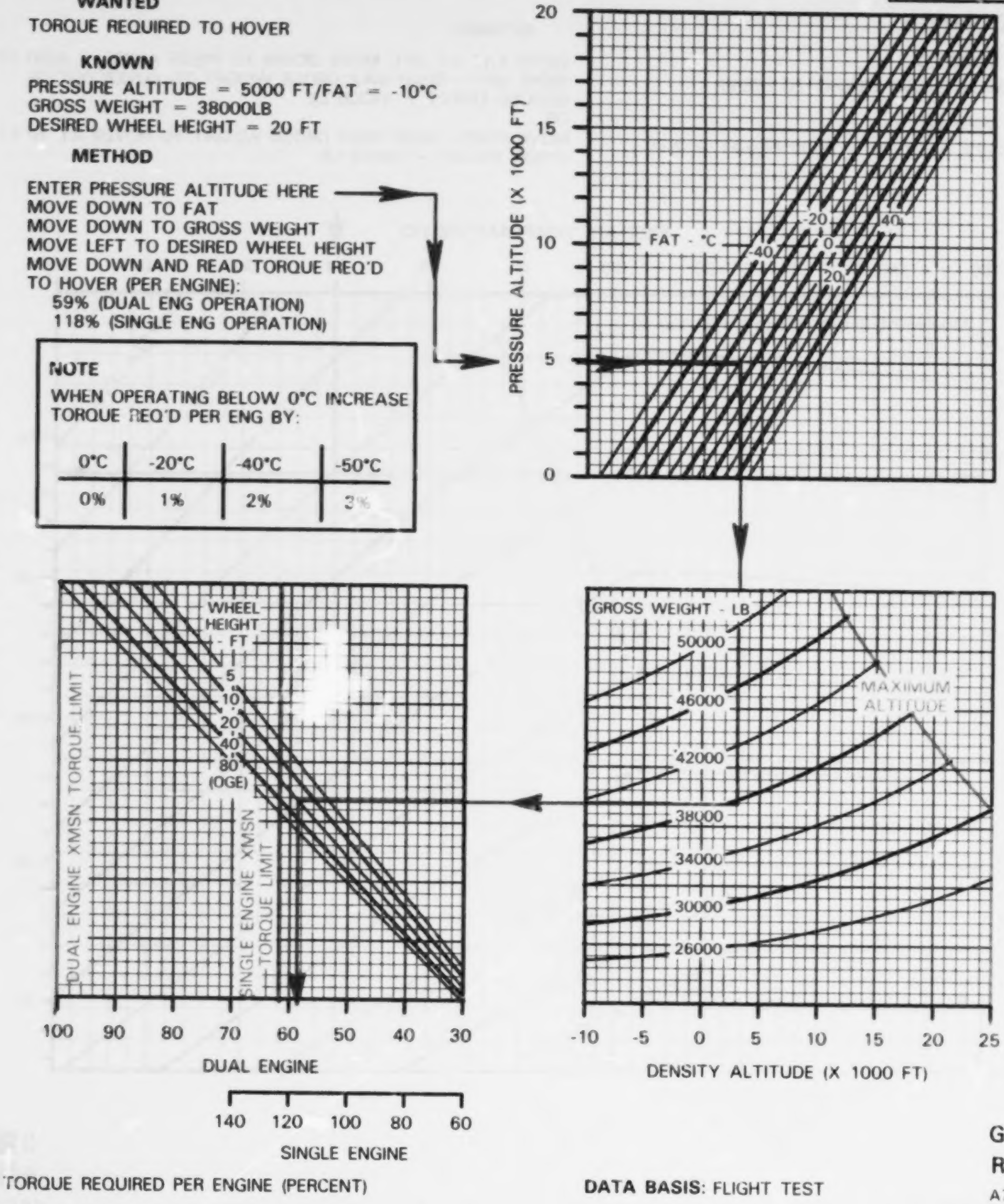
METHOD

ENTER PRESSURE ALTITUDE HERE
MOVE DOWN TO FAT
MOVE DOWN TO GROSS WEIGHT
MOVE LEFT TO DESIRED WHEEL HEIGHT
MOVE DOWN AND READ TORQUE REQ'D
TO HOVER (PER ENGINE):
59% (DUAL ENG OPERATION)
118% (SINGLE ENG OPERATION)

NOTE

WHEN OPERATING BELOW 0°C INCREASE TORQUE REQ'D PER ENG BY:

0°C	-20°C	-40°C	-50°C
0%	1%	2%	3%



TORQUE REQUIRED PER ENGINE (PERCENT)

DATA BASIS: FLIGHT TEST

G ■
R ■
A7886

Figure 7-6. Hover Chart

■ G
■ R

MAXIMUM GROSS WEIGHT TO HOVER
MAXIMUM POWER (10 MINUTES)
ENGINE ANTI-ICING OFF

HOVER
CH-47D
(2) T55-L-712

100% ROTOR RPM **TAS=0 KN**

EXAMPLE

WANTED

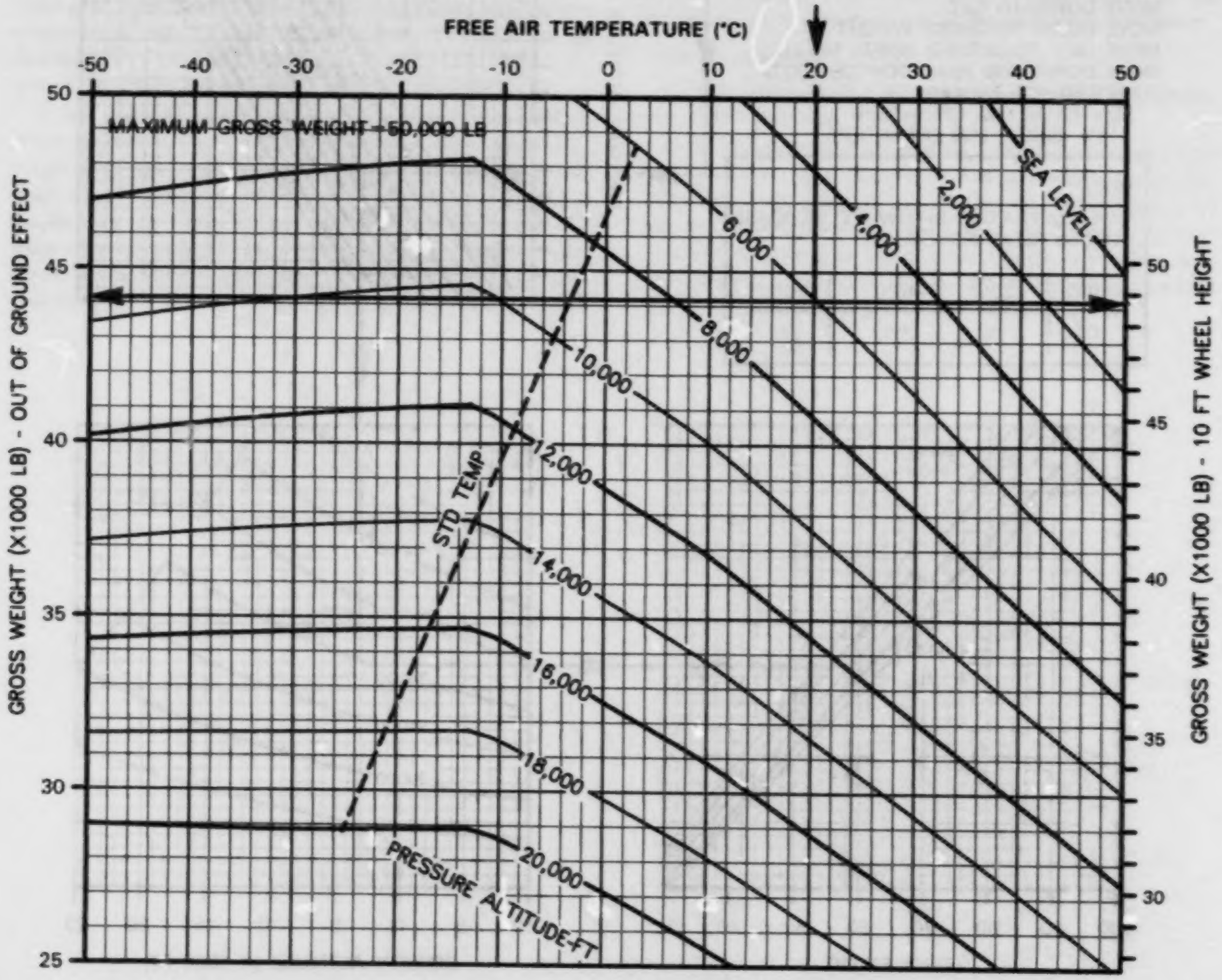
MAXIMUM GROSS WEIGHT TO HOVER

KNOWN

PRESSURE ALTITUDE = 6000 FT/FAT = 20°C

METHOD

ENTER FAT AT 20°C MOVE DOWN TO PRESS ALTIT. = 6000 FT
MOVE LEFT - READ MAX GROSS WEIGHT TO HOVER OUT OF GROUND EFFECT = 44300 LB
OR
MOVE RIGHT - READ MAX GROSS WEIGHT TO HOVER AT 10 FT WHEEL HEIGHT = 48800 LB



DATA BASIS: FLIGHT TEST

G ■
R ■
A9731

Figure 7-7. Hover Ceiling

SECTION VII TAKEOFF

7-26. Description.

The takeoff chart, figure 7-8 defines distances required to clear obstacles of 50 feet, 100 feet, 150 feet, and 200 feet based upon maximum hover height capability and true airspeed. The procedure for takeoff is the level flight acceleration technique.

NOTE

> The maximum hover heights shown are indicative of helicopter performance capability and do not imply that this hover height must be maintained thru takeoff.

7-27. Use of Chart.

The primary use of the chart is illustrated by the examples.

a. To determine the distance required to clear an obstacle, it is necessary to know maximum hover height (hover capability), obstacle height, and climbout true airspeed. Calculation of maximum hover height is described in Section V, Hover. Enter the chart for the required obstacle height, move right to desired true climbout airspeed, then down and read distance required to clear obstacle.

b. A hover check should be made prior to takeoff to verify hover capability. If winds are present, hover capability will be greater than predicted since the hover chart is based on calm wind conditions.

7-28. Conditions.

a. The takeoff chart is based on calm wind conditions. Since the surface wind velocity and direction cannot be accurately predicted, all takeoff planning should be based on calm air conditions. Takeoff into the wind will improve takeoff performance.

CAUTION

> A tailwind during takeoff and climbout will increase the distance for obstacle clearance and may prevent a successful takeoff.

b. Takeoff performance data are based on the use of maximum torque available at 100% rotor rpm.

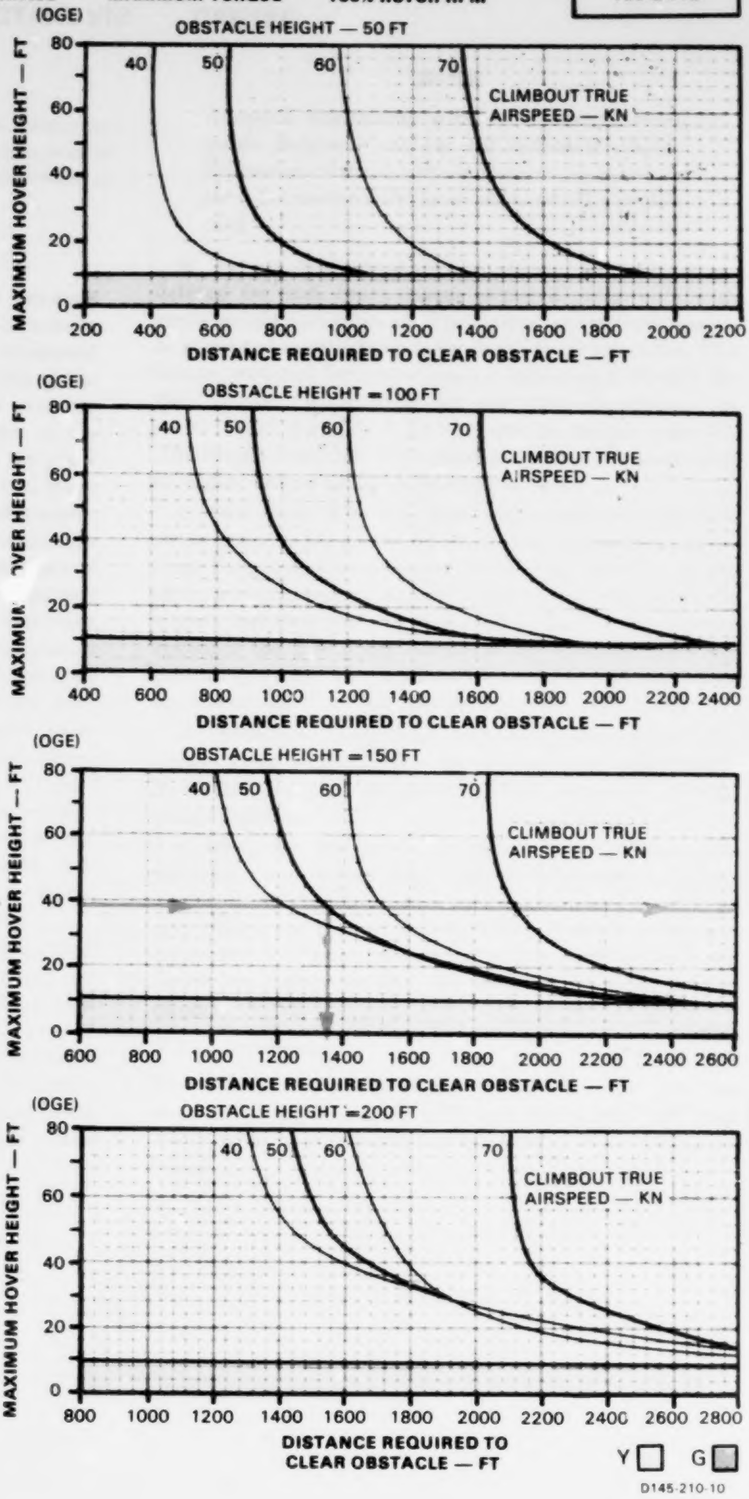
■ G
☐ Y

TAKEOFF

LEVEL ACCELERATION TECHNIQUE

CALM WIND LEVEL SURFACE MAXIMUM TORQUE 100% ROTOR RPM

TAKEOFF
CH-47D
T55-L-712



EXAMPLE

WANTED

DISTANCE TO CLEAR OBSTACLE

KNOWN

MAXIMUM HOVER HEIGHT = 40 FT
OBSTACLE HEIGHT = 125 FT
CLIMBOUT TRUE AIRSPEED = 50 KN

METHOD 1 (Simplest)

USE NEXT HIGHER OBSTACLE HEIGHT (150 FT)
ENTER MAX HOVER HEIGHT ON LEFT
MOVE RIGHT TO CLIMBOUT TRUE AIRSPEED
MOVE DOWN AND READ DISTANCE TO CLEAR
OBSTACLE = 1340 FT

METHOD 2 (Interpolate)

READ DISTANCE REQUIRED TO CLEAR
OBSTACLE AT EACH ADJACENT OBSTACLE
HEIGHT AND INTERPOLATE
OBSTACLE HEIGHT = 100 FT, 150 FT, 125 FT
DISTANCE REQUIRED = 1000 FT, 1340 FT, 1170 FT

DATA BASIS: FLIGHT TEST

Figure 7-8. Takeoff Chart

SECTION VIII CRUISE

7-29. Description.

The cruise charts, figures 7-9 thru 7-63 present torque requirements and fuel flow for cruise flight as a function of airspeed and gross weight for various combinations of pressure altitude and free air temperature.

7-30. Use of Charts.

The primary use of charts is illustrated by the example cruise chart (figure 7-9). To use the charts it is usually necessary to know the planned pressure altitude, estimated free air temperature, planned cruise tas, and the gross weight. First, select the proper chart based on pressure altitude and free air temperature. Enter the chart at the cruise tas, move right and read ias, move left to the gross weight, move down and read torque required, then move up and read associated fuel flow. Maximum performance conditions are determined by entering the chart where the maximum range line or maximum endurance and rate of climb line intersect the gross weight line; then read airspeed, fuel flow, and torque required. Normally, sufficient accuracy can be obtained by selecting the chart nearest to the planned cruising altitude and free air temperature, or move conservatively, by selecting the chart with the next higher altitude and free air temperature (example cruise chart, method one). If greater accuracy is required, interpolation between altitudes and/or temperatures is permissible (example cruise chart, method two). To be conservative, use the gross weight at the beginning of the cruise flight. For improved accuracy or long flights, it is preferable to determine cruise information for several flight segments to allow for decreasing gross weight.

a. Airspeed. True and indicated airspeeds are presented at opposite sides of each chart. On any chart, indicated airspeed can be directly converted to true airspeed (or vice versa) by reading directly across the chart without regard to other chart information. Estimated airspeed limits with an operating cruise guide indicator appear as red dashed lines on each chart. Airspeed limits with the cruise guide indicator inoperative are presented in the airspeed limits section of Chapter 5.

NOTE

Airspeed limitations with an operative cruise guide indicator are per the indicator display. Estimated values shown on these cruise charts are for information only, as an aid to pre-flight planning.

b. Torque. Since pressure altitude and temperature are defined for each chart, torque required varies only with gross weight and airspeed. The torque required per engine as presented on the charts is for dual engine operation. The torque required for single engine operation is double the dual engine torque value for any given condition. See cruise chart example 2 for example on torque required. The torque available limits shown are either transmission or engine torque limits (whichever is least).

c. Fuel Flow. The fuel flow scales presented on each chart opposite the torque scales are for dual engine operation. Torque may be converted directly to fuel flow on any chart without regard to other chart information. A single engine fuel flow chart is presented in Section XI. Torque required for any given condition as obtained from the preceding cruise charts should be doubled before being used to obtain single engine fuel flow from this chart.

d. Maximum Range. Maximum range lines indicate optimum gross weight/cruise speed conditions with respect to distance covered per pound of fuel consumed for zero wind condition.

e. Maximum Endurance and Rate of Climb. Maximum endurance and rate of climb lines indicate optimum gross weight/cruise speed conditions for maximum endurance and maximum rate of climb. These conditions require minimum fuel flow (maximum endurance) and provide maximum torque change for climb (maximum rate of climb).

7-31. Conditions.

The cruise charts are based on 100% rotor rpm for ambient temperatures of -10°C and above, and 98% and 100% rotor rpm for ambient temperatures of -20°C and below.

CRUISE EXAMPLE

EXAMPLE 1 (DUAL ENGINE)

WANTED

SPEED FOR MAXIMUM ENDURANCE
SPEED FOR MAXIMUM RANGE
MAX. SPEED AT CONTINUOUS TORQUE RATING
ESTIMATED AIRSPEED LIMIT WITH CRUISE GUIDE INDICATOR OPERATIVE

KNOWN

GROSS WEIGHT = 50000 LB
PRESSURE ALTITUDE = SEA-LEVEL
FAT = 30°C

METHOD

READ SPEEDS WHERE GROSS WEIGHT LINE INTERSECTS PERFORMANCE OR LIMIT LINE

MAXIMUM ENDURANCE: TAS = 83 KN, IAS = 85 KN

MAXIMUM RANGE: TAS = 143 KN, IAS = 139 KN (REQUIRES POWER IN EXCESS OF MAXIMUM CONTINUOUS POWER)

MAX. SPEED (CONTINUOUS TORQUE RATING): TAS = 128 KN, IAS = 125 KN

ESTIMATED AIRSPEED LIMIT (VCGI): 146 KN, IAS = 143 KN

EXAMPLE 2 (DUAL ENGINE) (DASHED GREEN LINE)

WANTED

TORQUE REQUIRED FOR LEVEL FLIGHT, FUEL FLOW, AND INDICATED AIRSPEED

KNOWN

GROSS WEIGHT = 46000 LB
PRESSURE ALTITUDE = SEA LEVEL
FAT = 35°C
TRUE AIRSPEED = 120 KN

METHOD 1 (SIMPLEST)

USE NEXT HIGHER TEMPERATURE (40°C)

ENTER TAS, MOVE RIGHT TO GROSS WEIGHT

MOVE DOWN READ TORQUE REQ'D = 56% (PER ENGINE)

MOVE UP READ FUEL FLOW = 2710 LB/HR (TOTAL)

MOVE RIGHT READ IAS = 115 KN

METHOD 2 (INTERPOLATE)

READ TORQUE REQ'D, FUEL FLOW, AND IAS AT EACH ADJACENT TEMPERATURE THEN INTERPOLATE BETWEEN TEMPERATURES.

REFER TO THE TABLE BELOW.

PRESSURE ALTITUDE	SEA LEVEL	SEA LEVEL	SEA LEVEL
FAT	30°C	40°C	35°C
TORQUE REQ'D (%)	56%	56%	56%
FUEL FLOW (LB/HR)	2690	2710	2700
IAS (KNOTS)	117	115	116

Figure 7-9. Example Cruise Chart (Sheet 1 of 2)

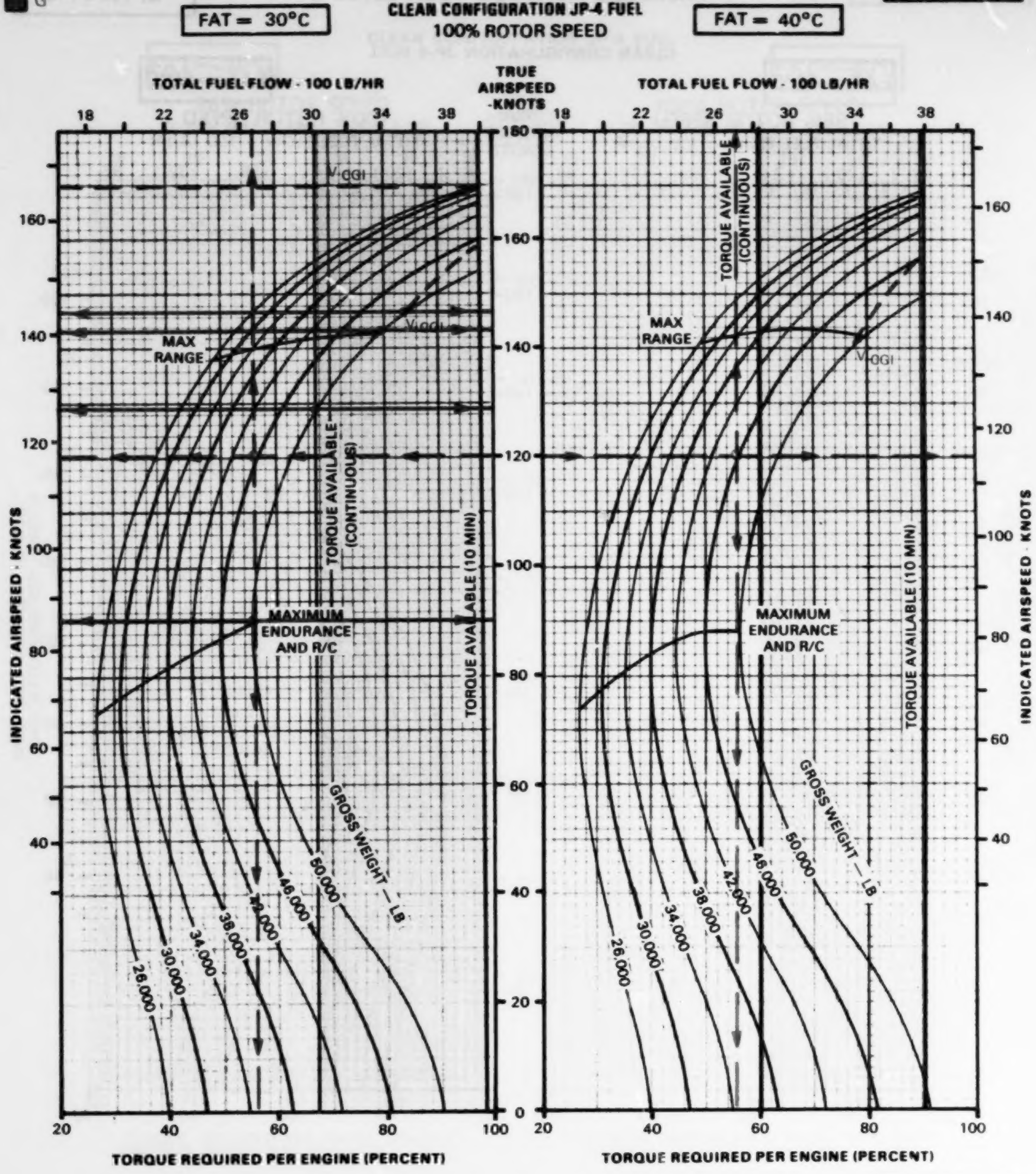
■ R
☐
■ G

CRUISE
CH-47D
(2) T55-L-712

CRUISE

PRESSURE ALTITUDE — SEA LEVEL

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED



G ■ Y ☐ R ■

D145-216-10

DATA BASIS: FLIGHT TEST

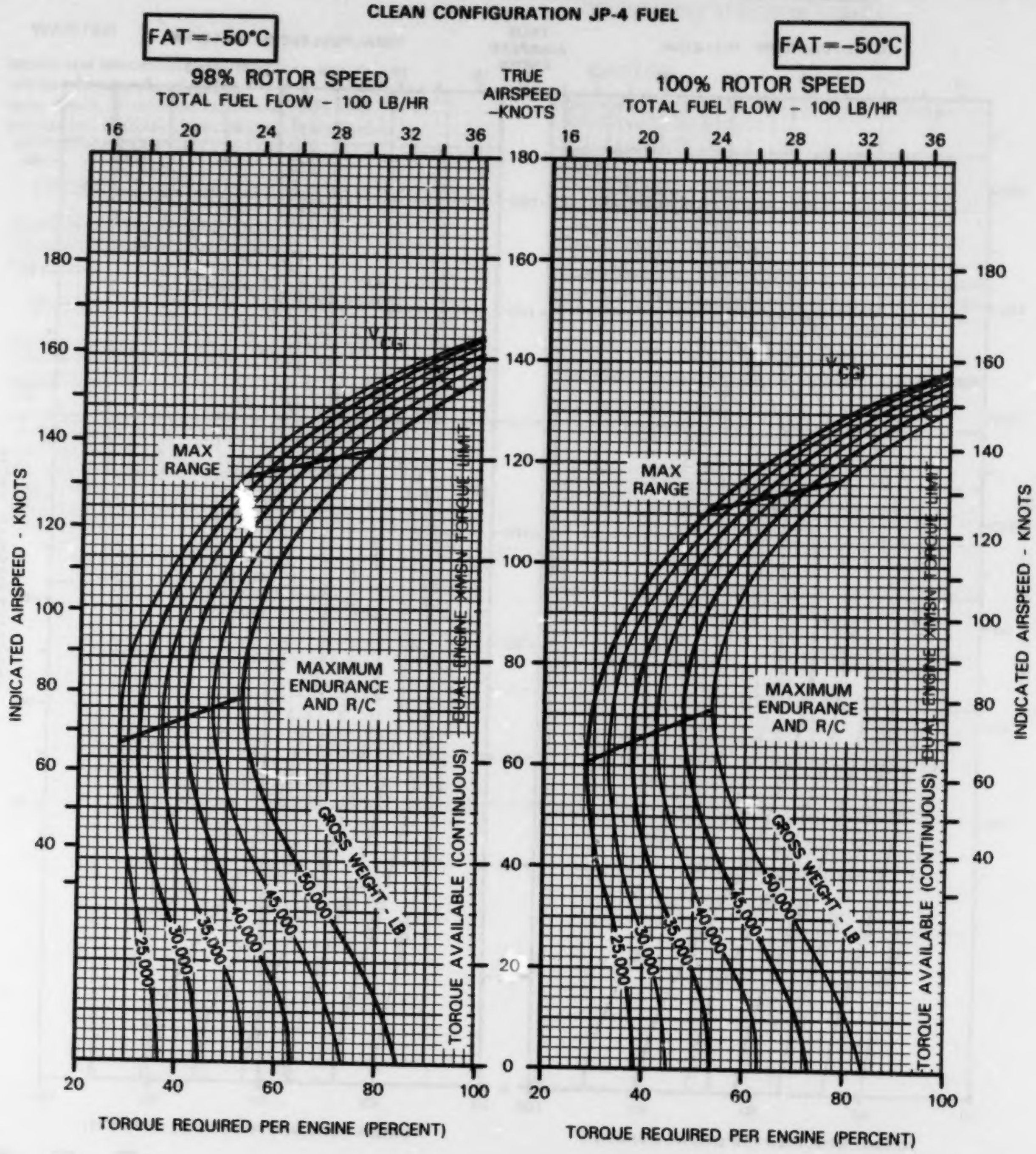
Figure 7-9. Example Cruise Chart (Sheet 2 of 2)

CRUISE

PRESSURE ALTITUDE - SEA LEVEL

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

A9143

Figure 7-10. 98 and 100% Rotor RPM, -50°C, Sea Level

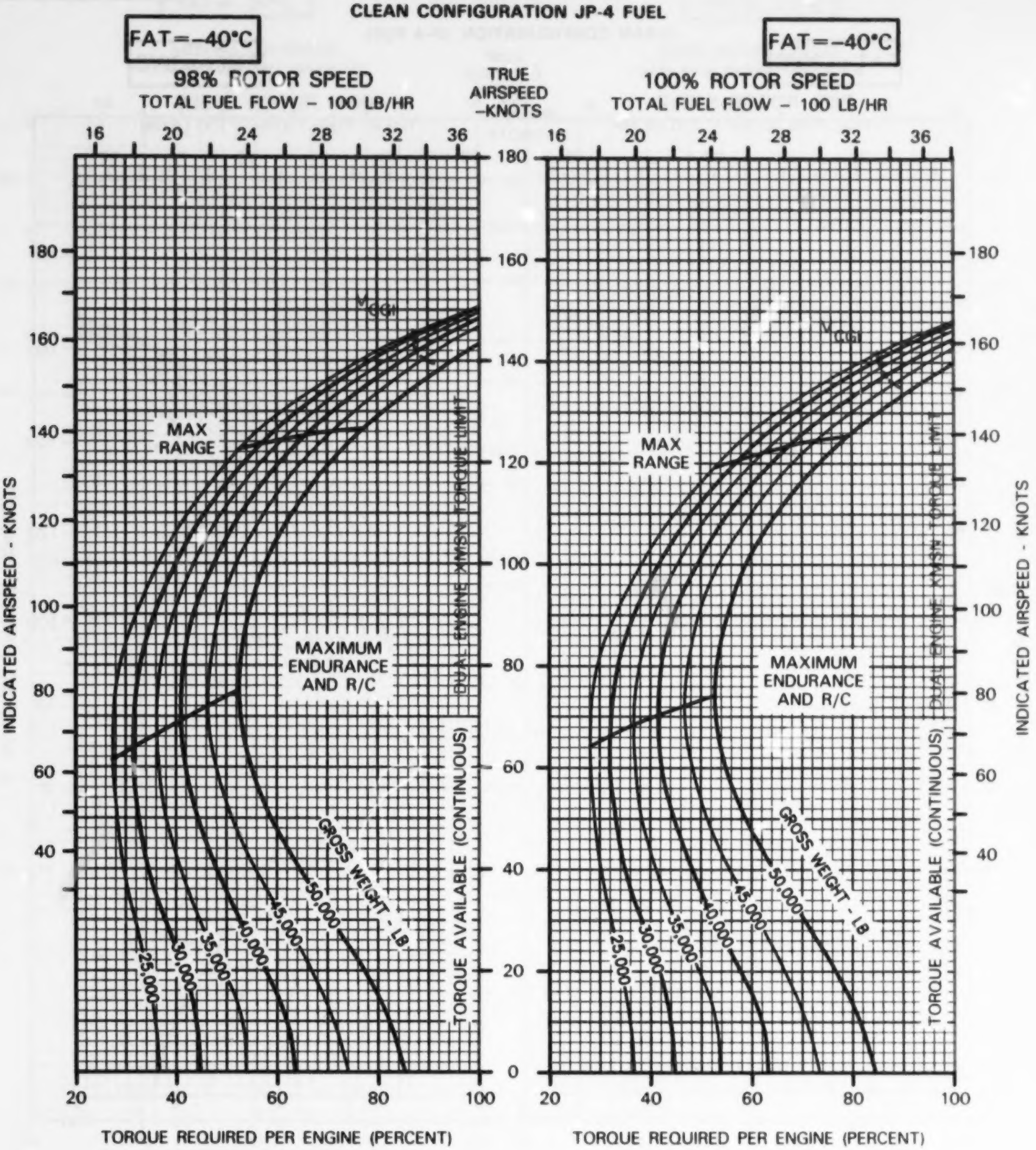
R

CRUISE
CH-47D
(2) T55-L-712

CRUISE

PRESSURE ALTITUDE - SEA LEVEL

CLEAN CONFIGURATION JP-4 FUEL



R

A9144

DATA BASIS: FLIGHT TEST

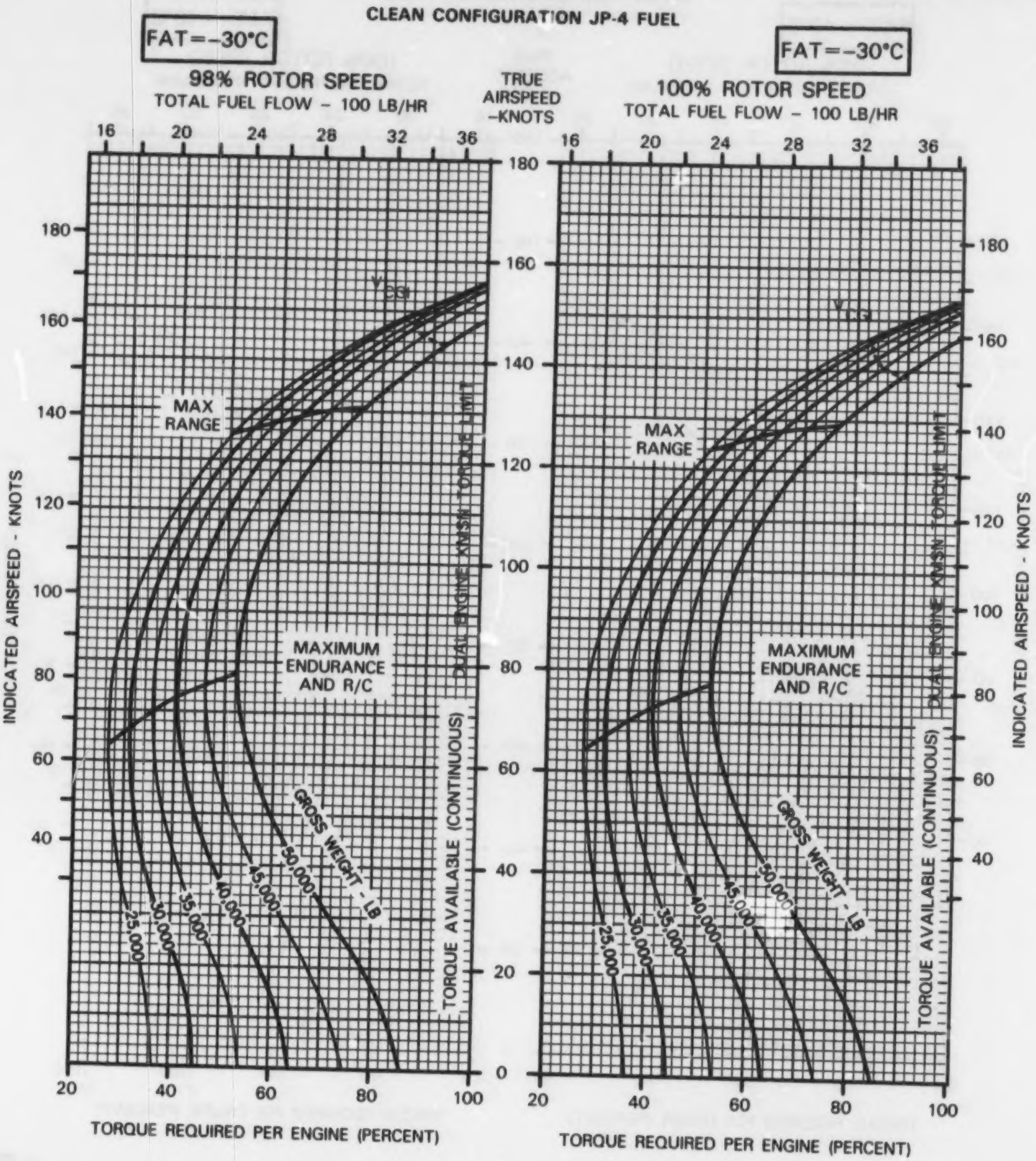
Figure 7-10.1. 98 and 100% Rotor RPM, -40°C, Sea Level

R ■

CRUISE
PRESSURE ALTITUDE - SEA LEVEL

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

R ■
A9145

Figure 7-10.2. 98 and 100% Rotor RPM, -30°C, Sea Level

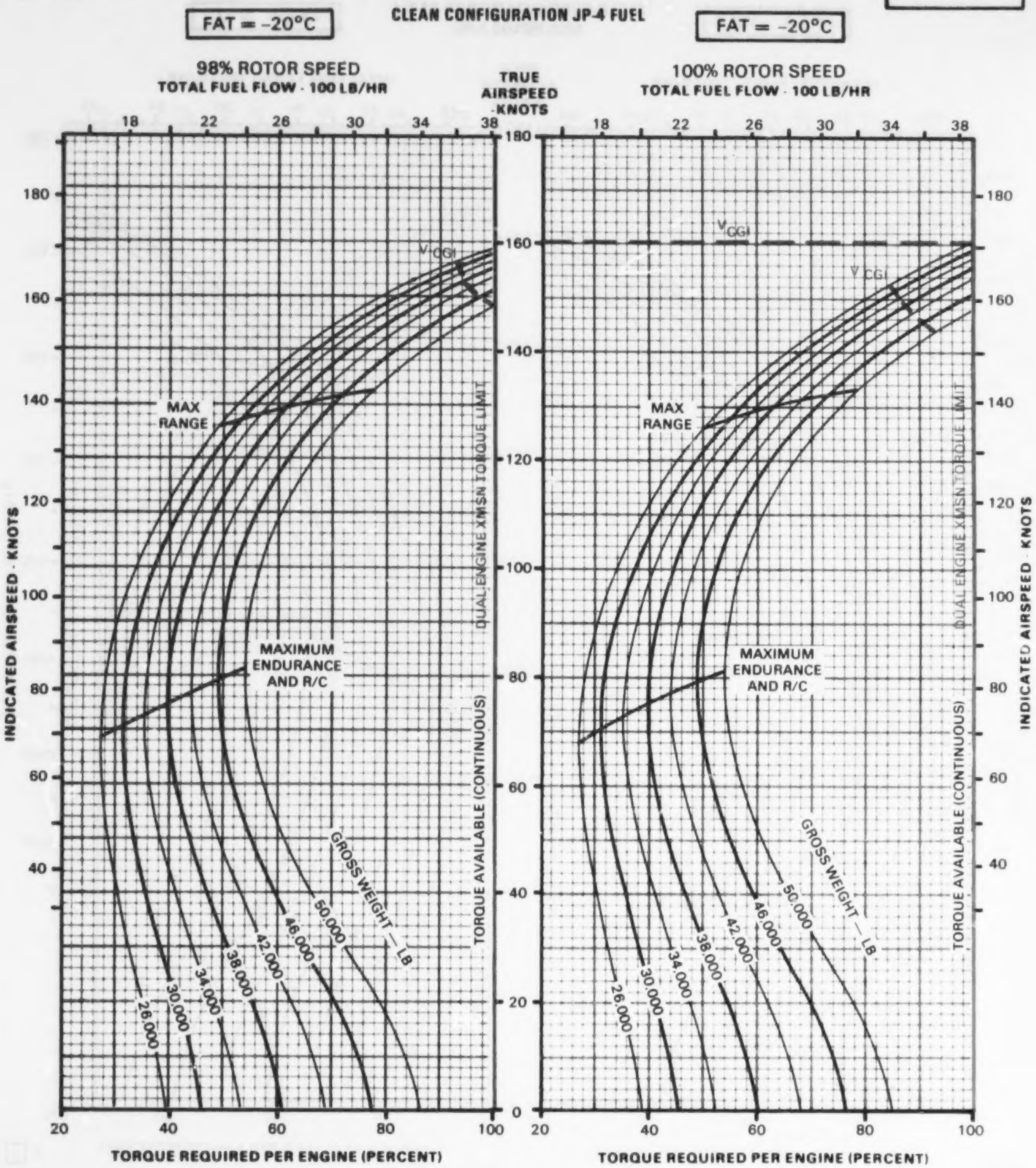
R

CRUISE

PRESSURE ALTITUDE — SEA LEVEL

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

R

D145-213-10

Figure 7-11. 98 and 100% Rotor RPM, -20°C, Sea Level

■ R
☐

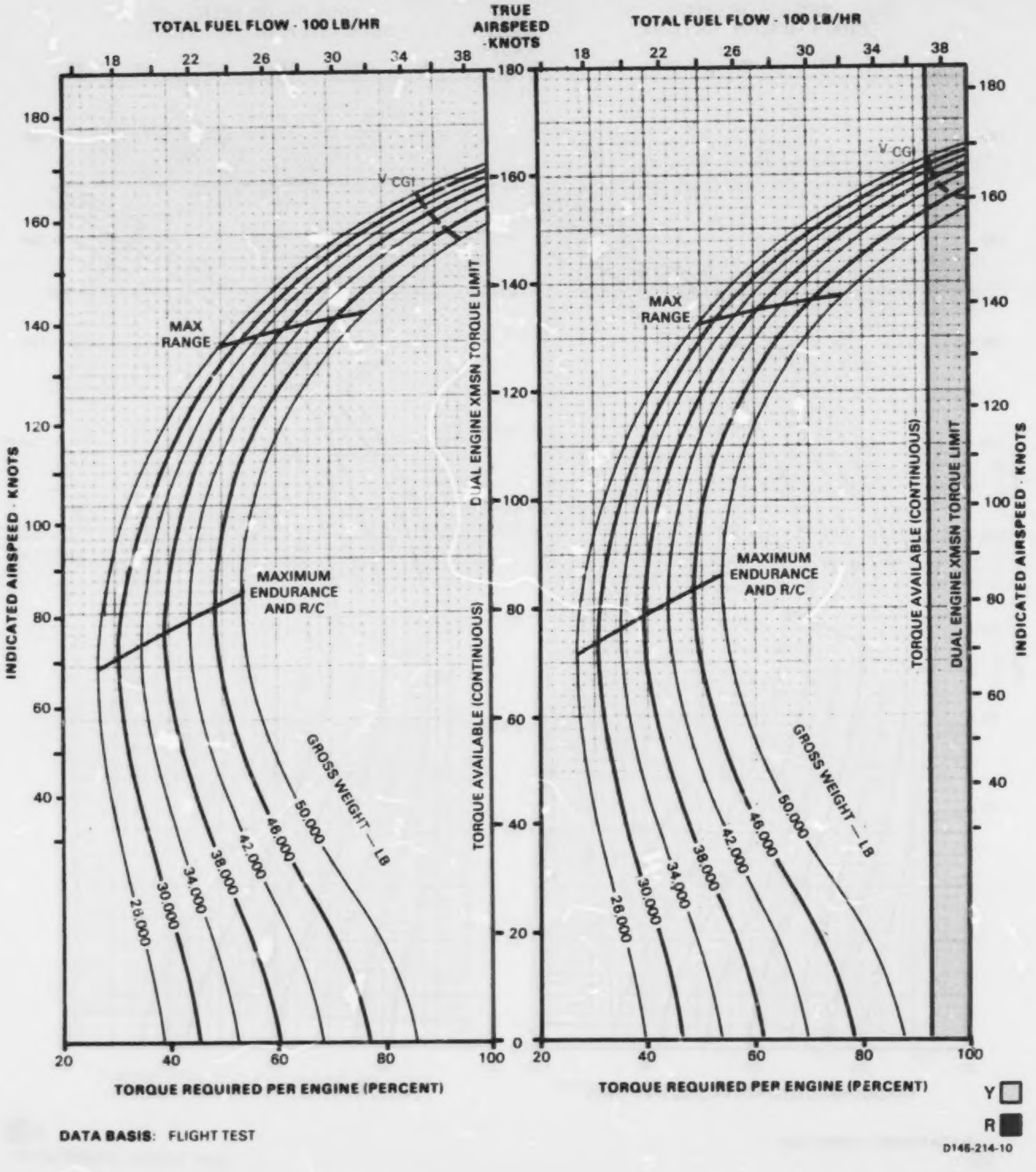
CRUISE
PRESSURE ALTITUDE — SEA LEVEL

CRUISE
CH-47D
(2) T55-L-712

FAT = -10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR RPM

FAT = 0°C



Y ☐
R ■

DATA BASIS: FLIGHT TEST

D146-214-10

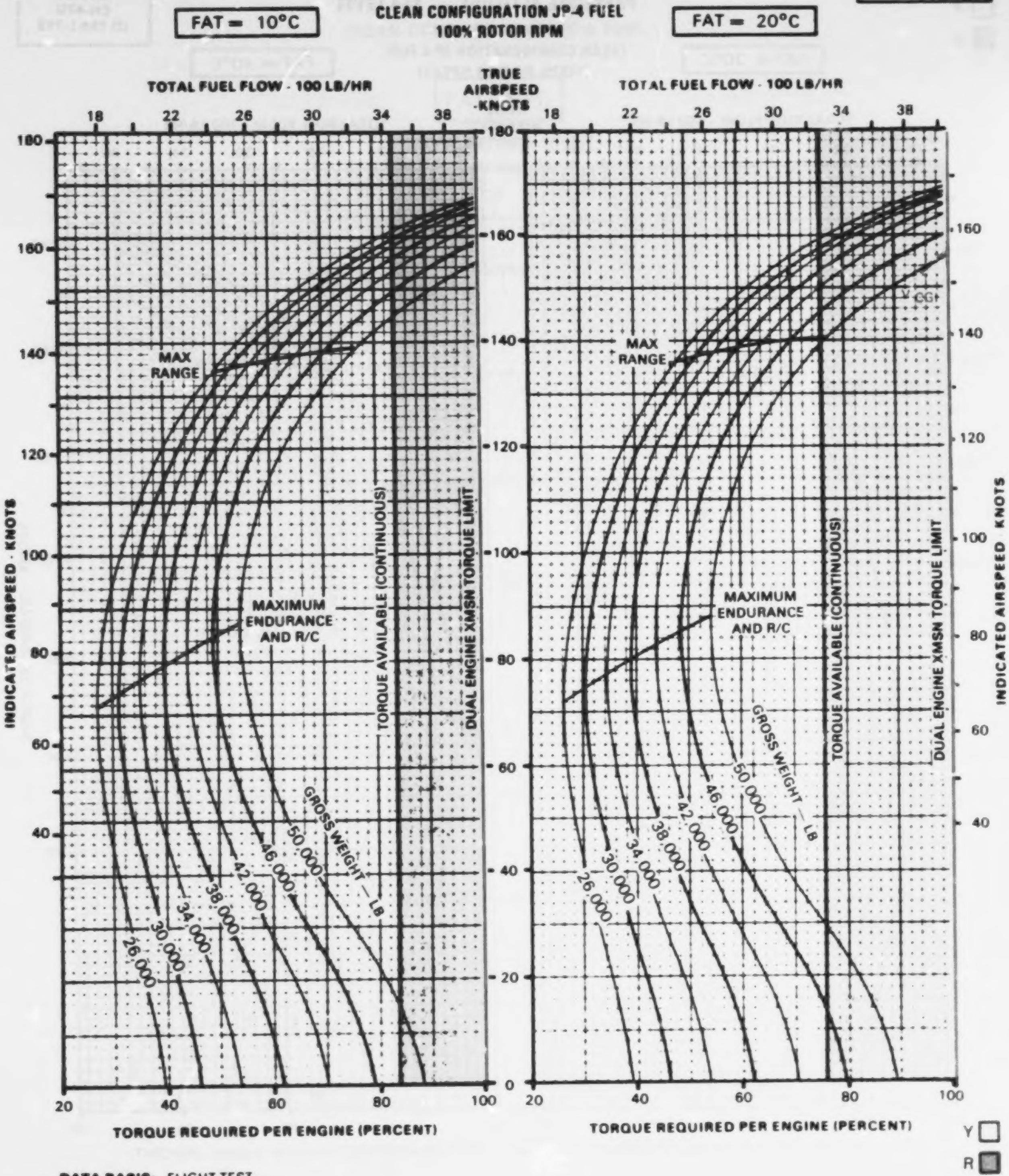
Figure 7-12. 100% Rotor RPM, -10° and 0°C, Sea Level

▇ R
☐ Y

CRUISE

PRESSURE ALTITUDE — SEA LEVEL

CRUISE
CH-47D
(2) T55-L-712



DATA BASIS: FLIGHT TEST

778

Figure 7-13. 100% Rotor RPM, 10° and 20°C, Sea Level

■ R
□ Y
■ G

CRUISE

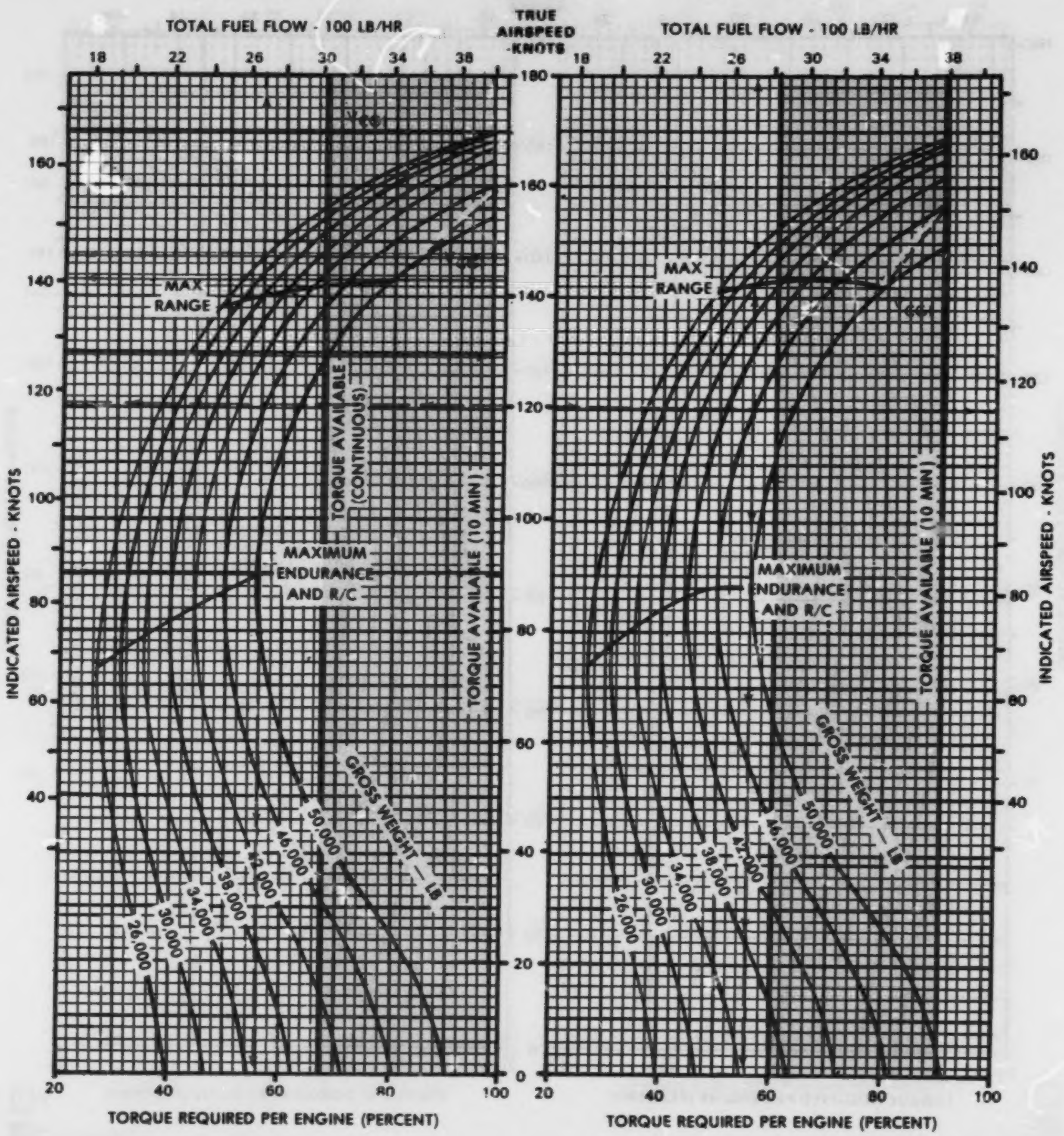
PRESSURE ALTITUDE — SEA LEVEL

CRUISE
CH-47D
(2) T55-L-712

FAT = 30°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 40°C



DATA BASIS: FLIGHT TEST

G ■ Y □ R ■

Figure 7-14. 100% Rotor RPM, 30° and 40°C, Sea Level

R ■

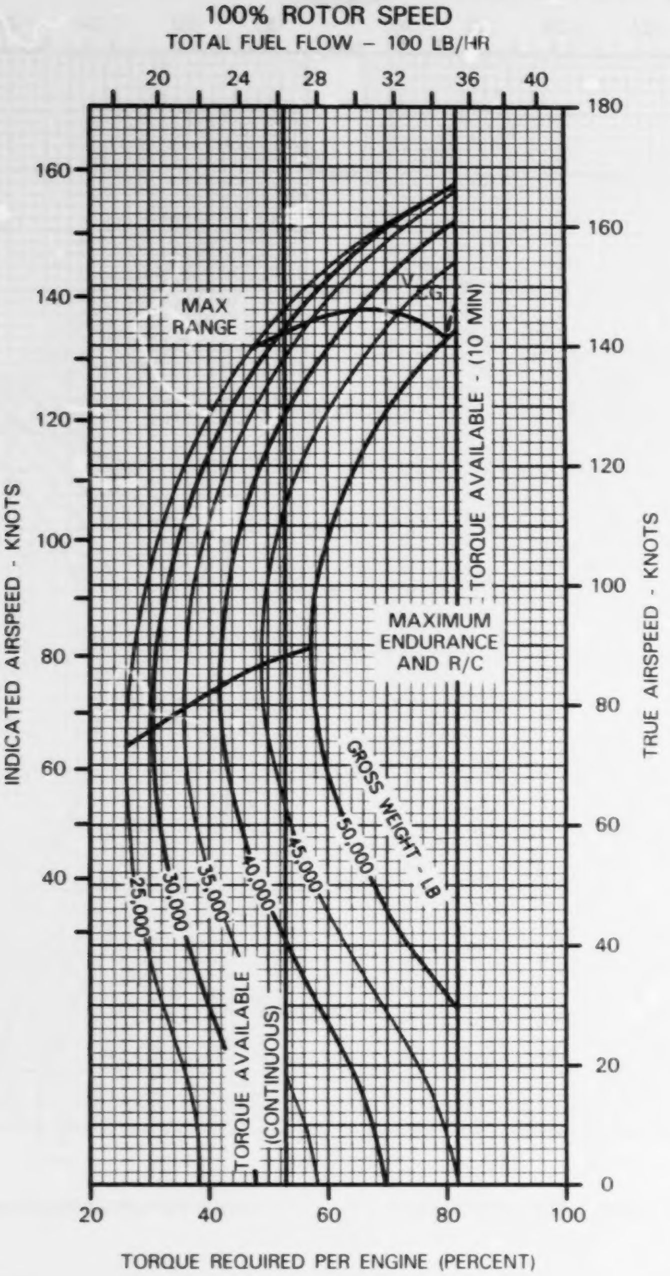
CRUISE

PRESSURE ALTITUDE - SEA LEVEL

CLEAN CONFIGURATION JP-4 FUEL

CRUISE
CH-47D
(2) T55-L-712

FAT=50°C



DATA BASIS: FLIGHT TEST

R ■
A9405

Figure 7-14.1. 100% Rotor RPM, 50°C, Sea Level

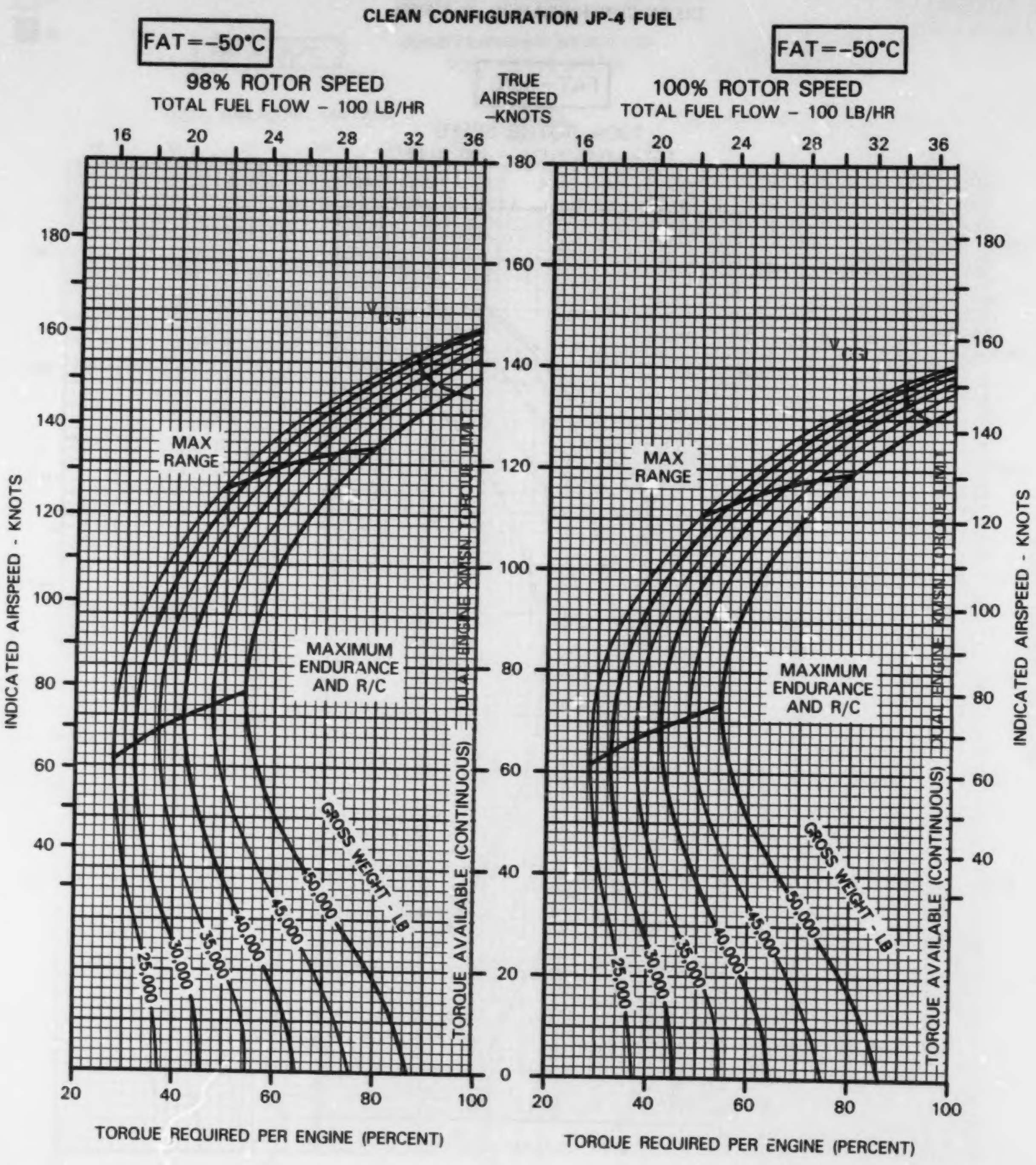
R ■

CRUISE

PRESSURE ALTITUDE - 2000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

R ■
A9146

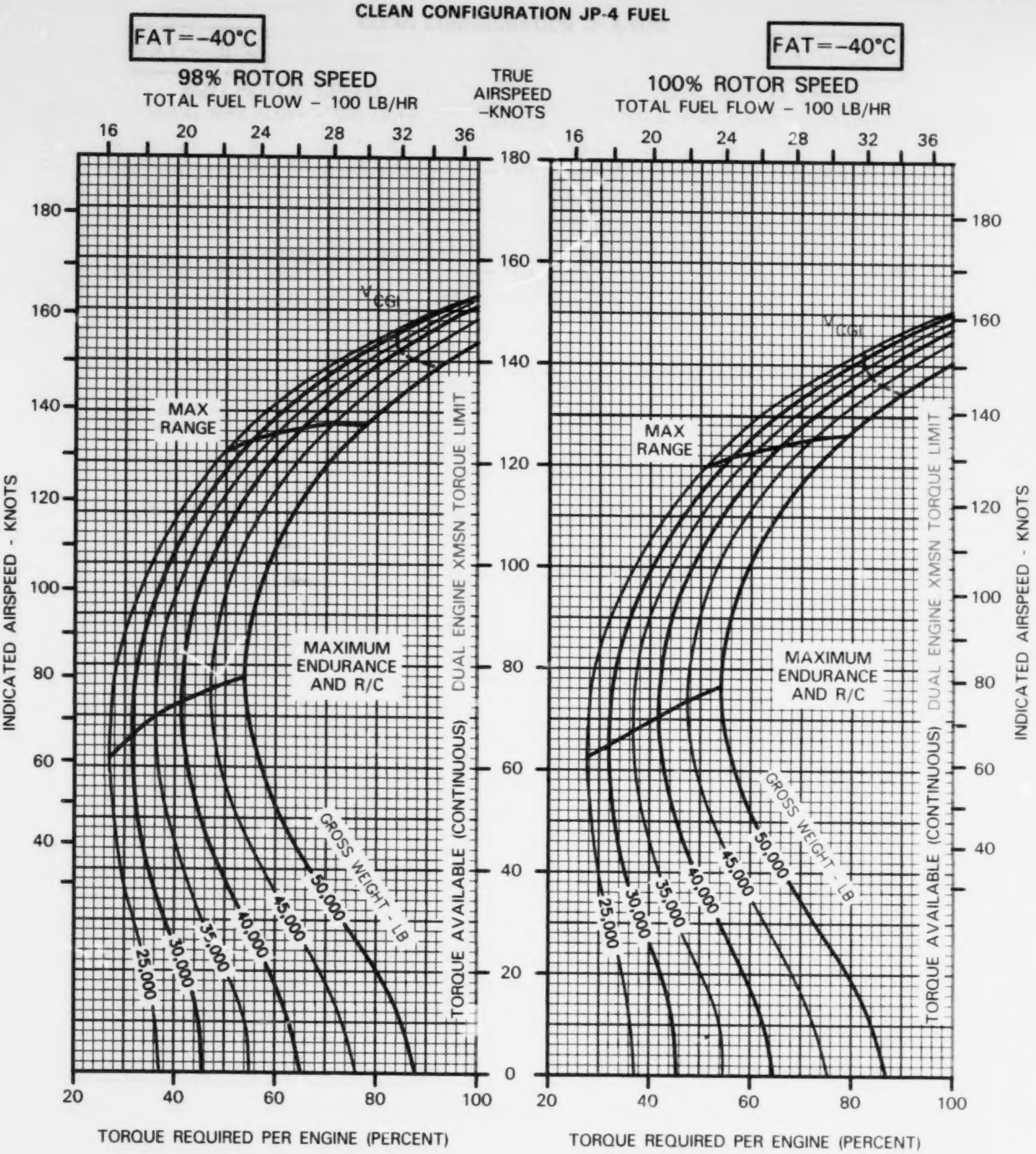
Figure 7-15. 98 and 100% Rotor RPM, -50°C, 2,000 Feet

CRUISE

PRESSURE ALTITUDE - 2000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

A9406

Figure 7-15.1. 98 and 100% Rotor RPM, -40°C, 2,000 Feet

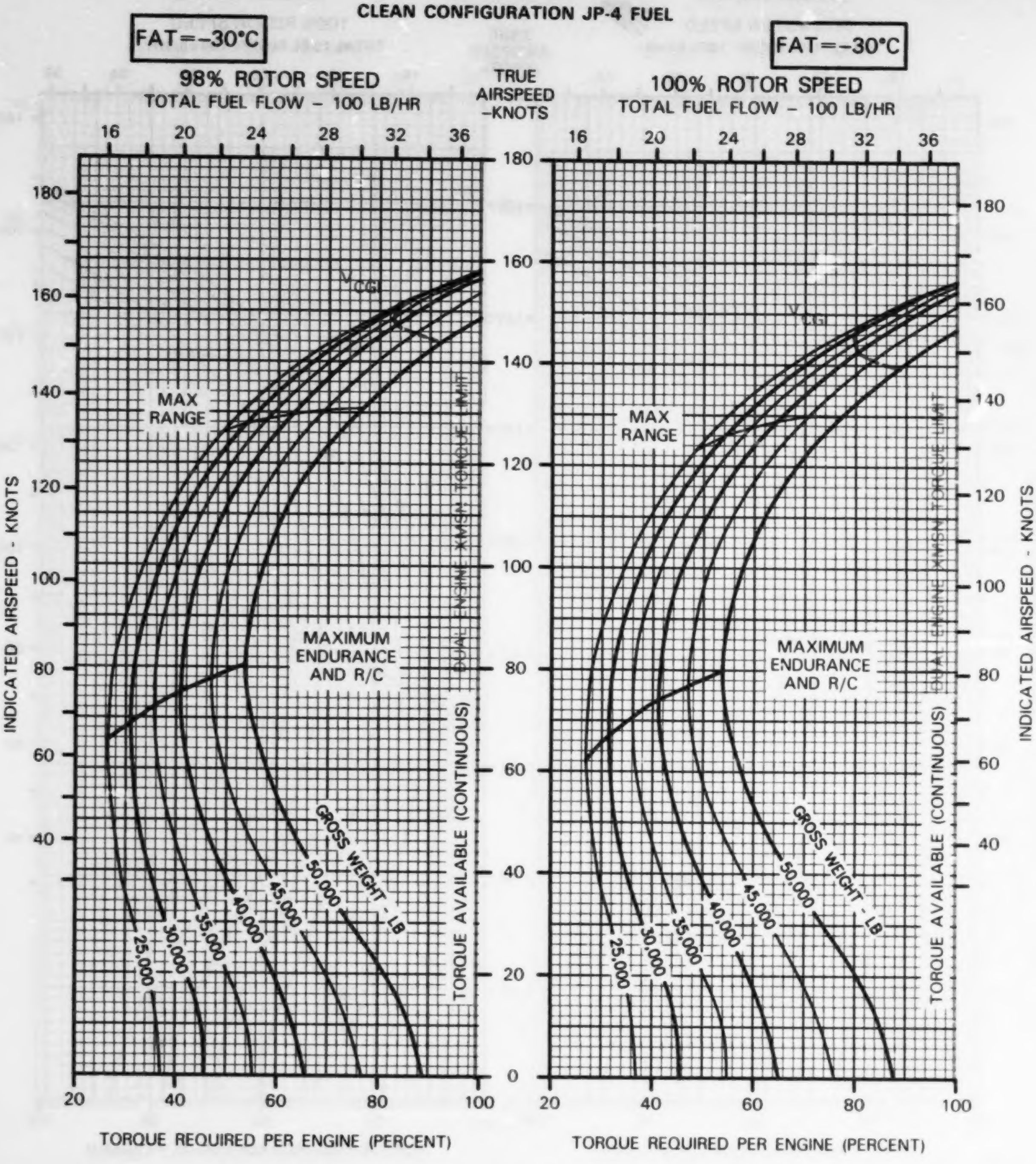
R

CRUISE

PRESSURE ALTITUDE - 2000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

R

A9147

Figure 7-15.2. 98 and 100% Rotor RPM, –30°C, 2,000 Feet

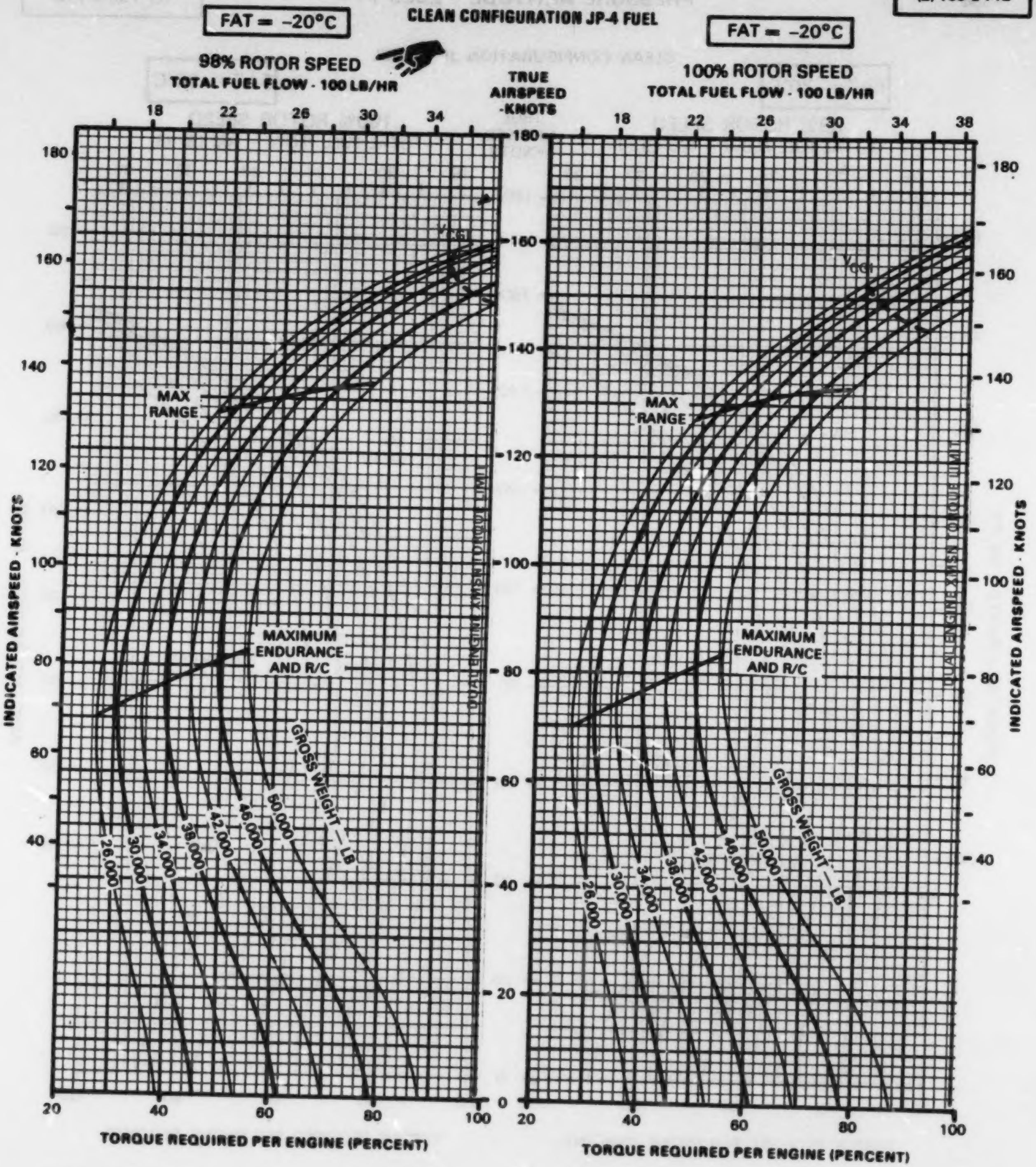
R

CRUISE
CH-47D
(2) T55-L-712

CRUISE

PRESSURE ALTITUDE — 2000 FT

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

R

D145-218-10

Figure 7-16. 98 and 100% Rotor RPM, -20°C, 2,000 Feet

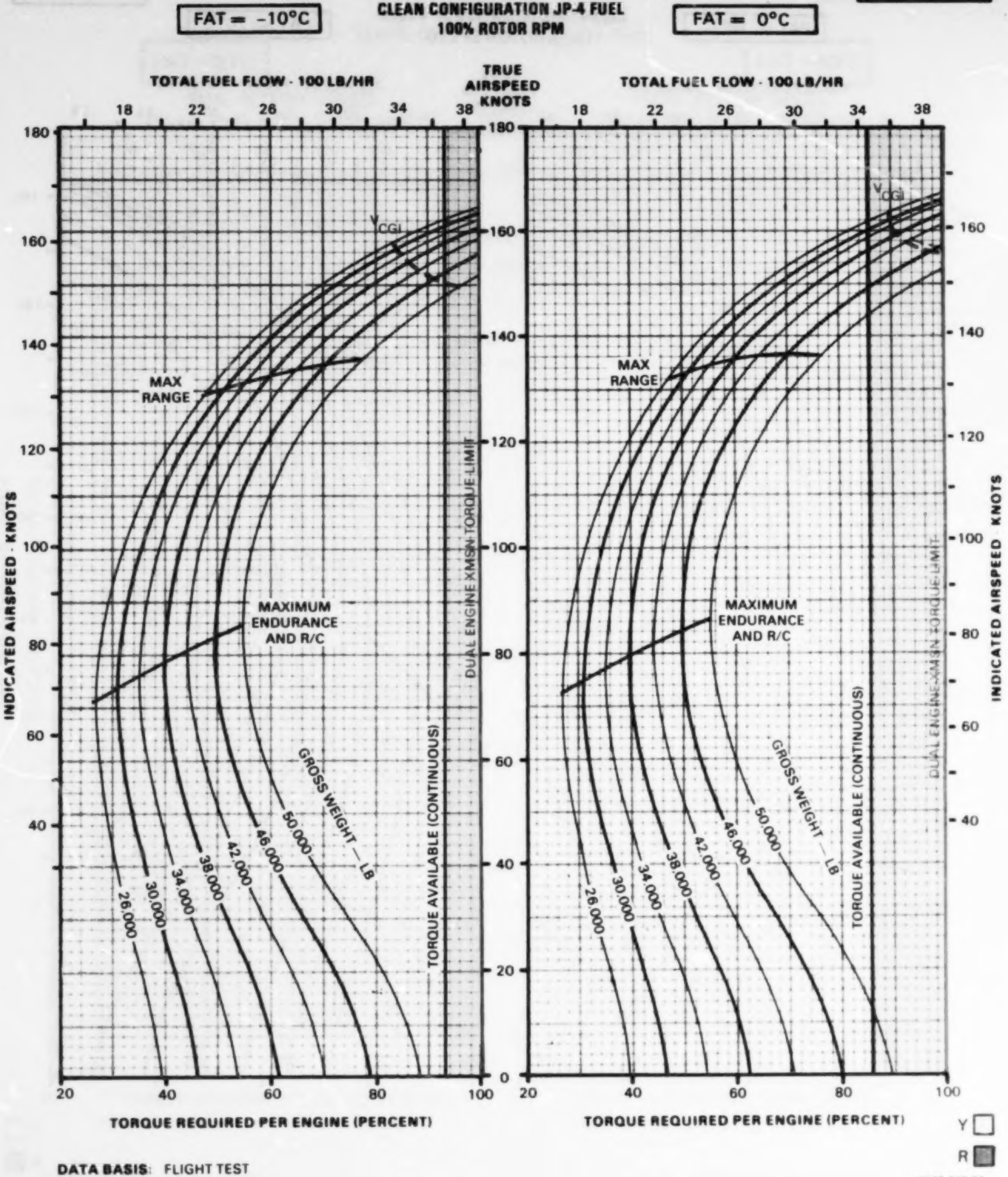
▨ R

CRUISE

PRESSURE ALTITUDE — 2000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR RPM



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

D145-219-10

Figure 7-17. 100% Rotor RPM, -10° and 0°C, 2,000 Feet

■ R

☐

CRUISE

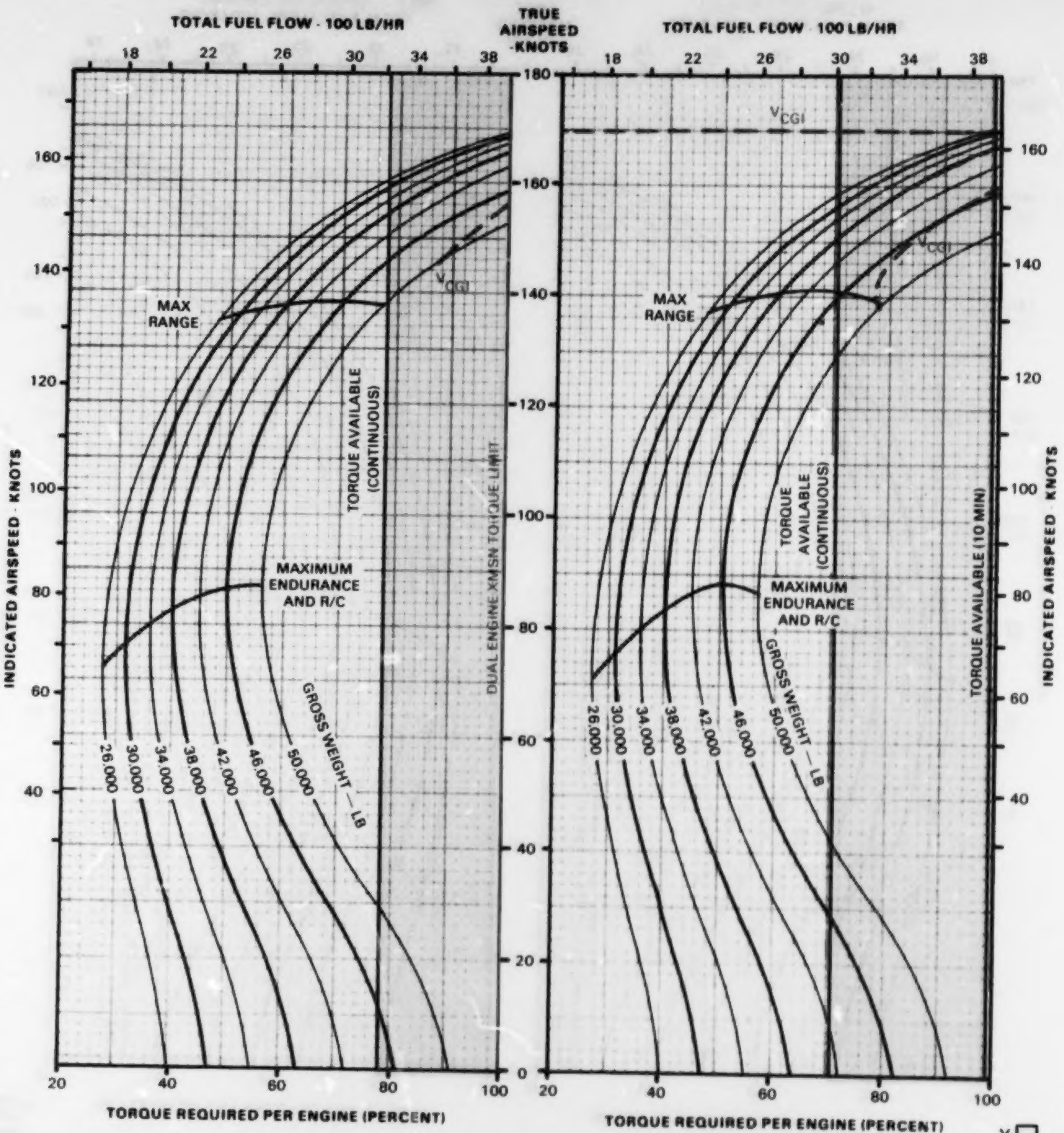
PRESSURE ALTITUDE — 2000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = 10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 20°C



DATA BASIS: DERIVED FROM FLIGHT TEST

Y ☐

R ■

D145-220-10

Figure 7-18. 100% Rotor RPM, 10° and 20° C, 2,000 Feet

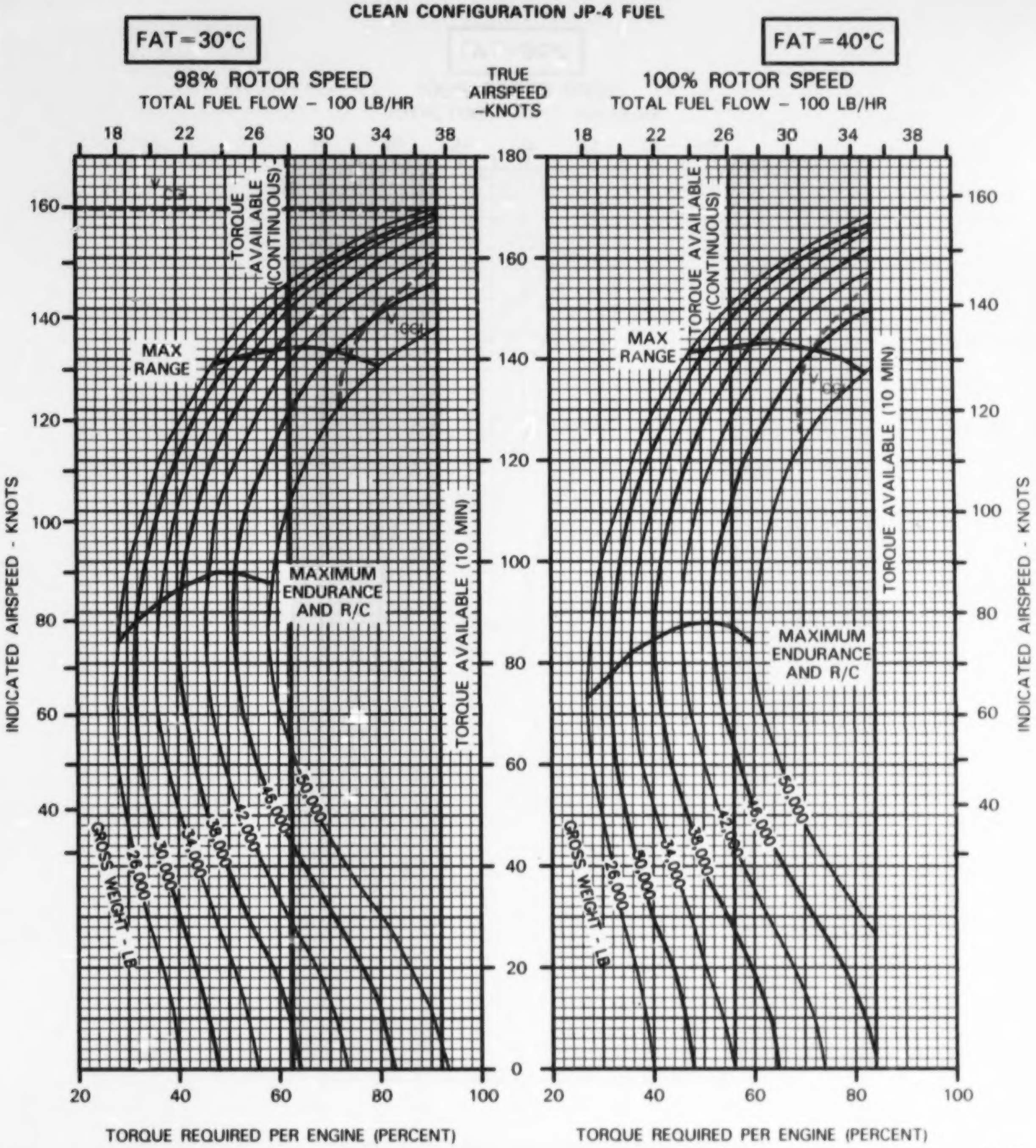
Y ☐
R ■

CRUISE

PRESSURE ALTITUDE - 2,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

A11898

Figure 7-19. 100% Rotor RPM, 30° and 40°C, 2,000 Feet

Y ☐
R ■

CRUISE
CH-47D
(2) T55-L-712

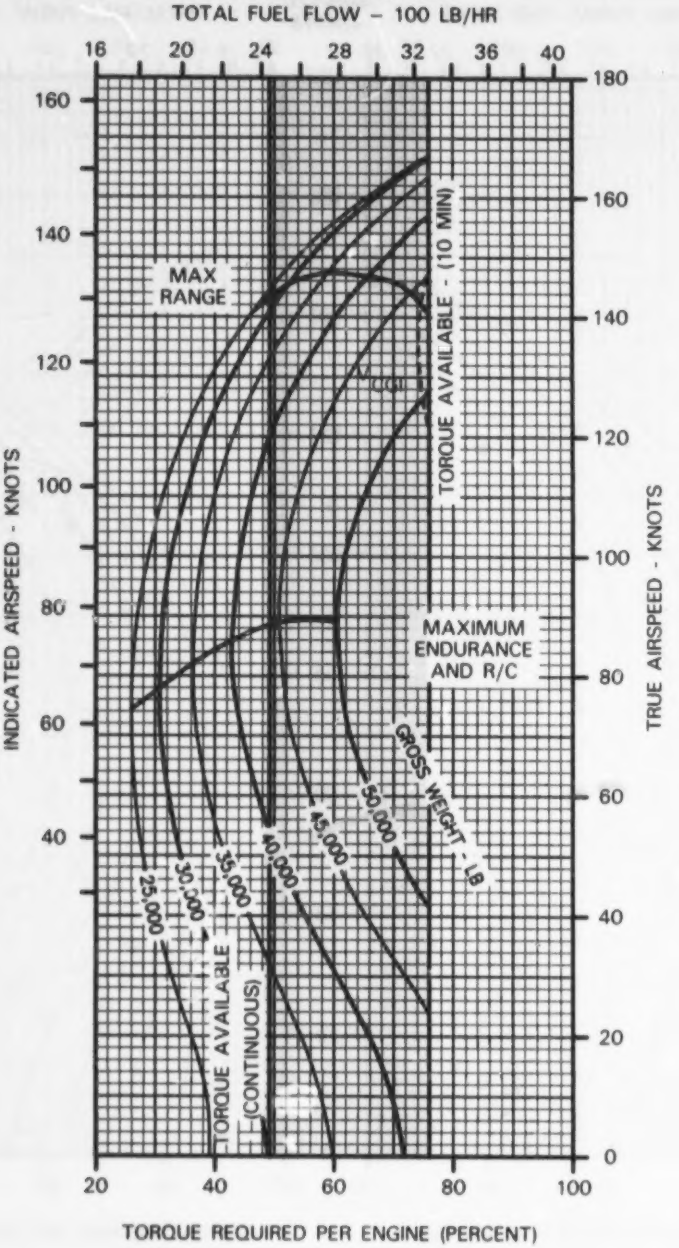
CRUISE

PRESSURE ALTITUDE - 2000 FT

CLEAN CONFIGURATION JP-4 FUEL

FAT=50°C

100% ROTOR SPEED



DATA BASIS: FLIGHT TEST

☐
R ■

A9148

Figure 7-19.1. 100% Rotor RPM, 50°C, 2,000 Feet

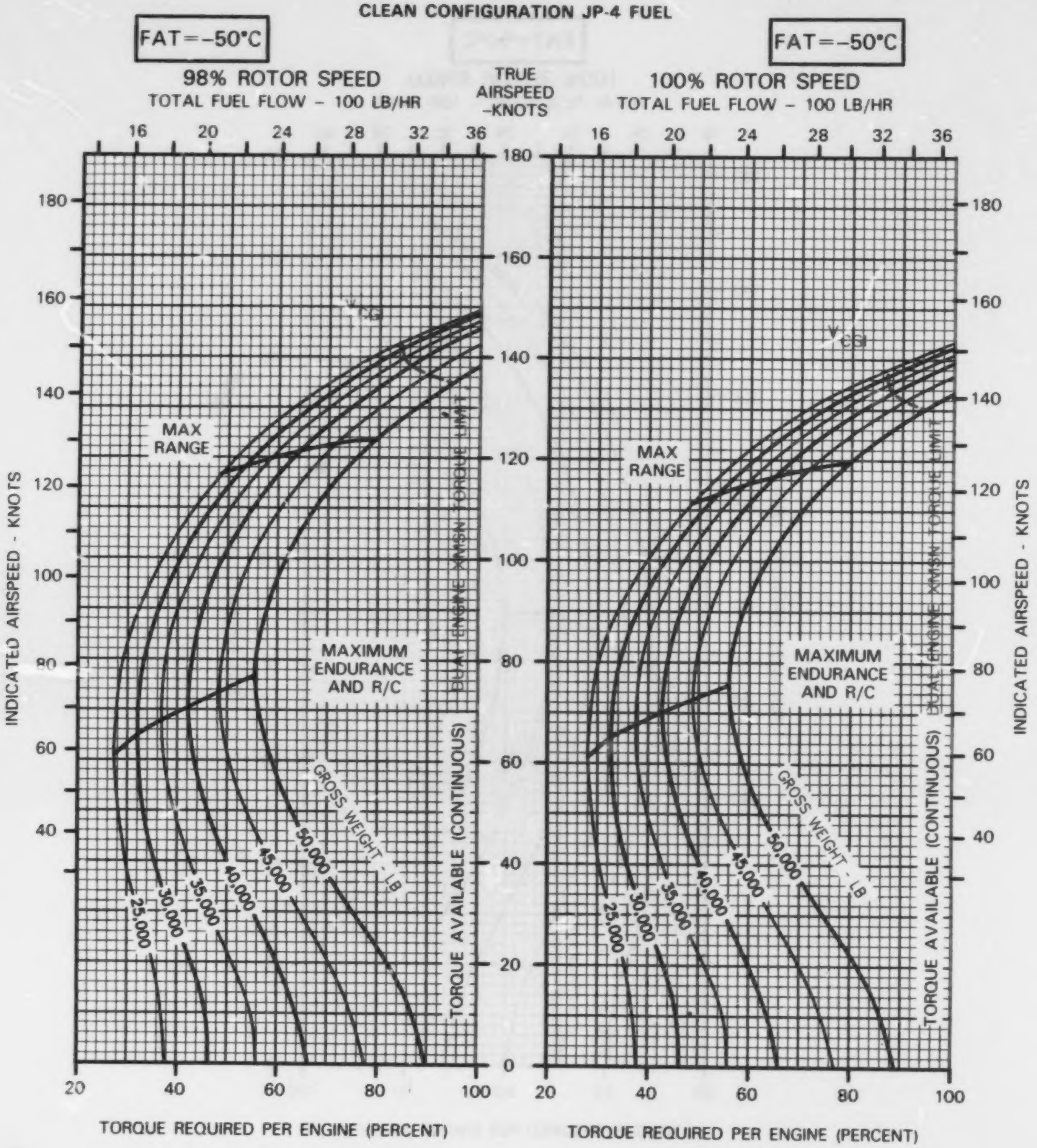
R

CRUISE

PRESSURE ALTITUDE - 4000 FT

CLEAN CONFIGURATION JP-4 FUEL

CRUISE
CH-47D
(2) T55-L-712



DATA BASIS: FLIGHT TEST

R
A9125

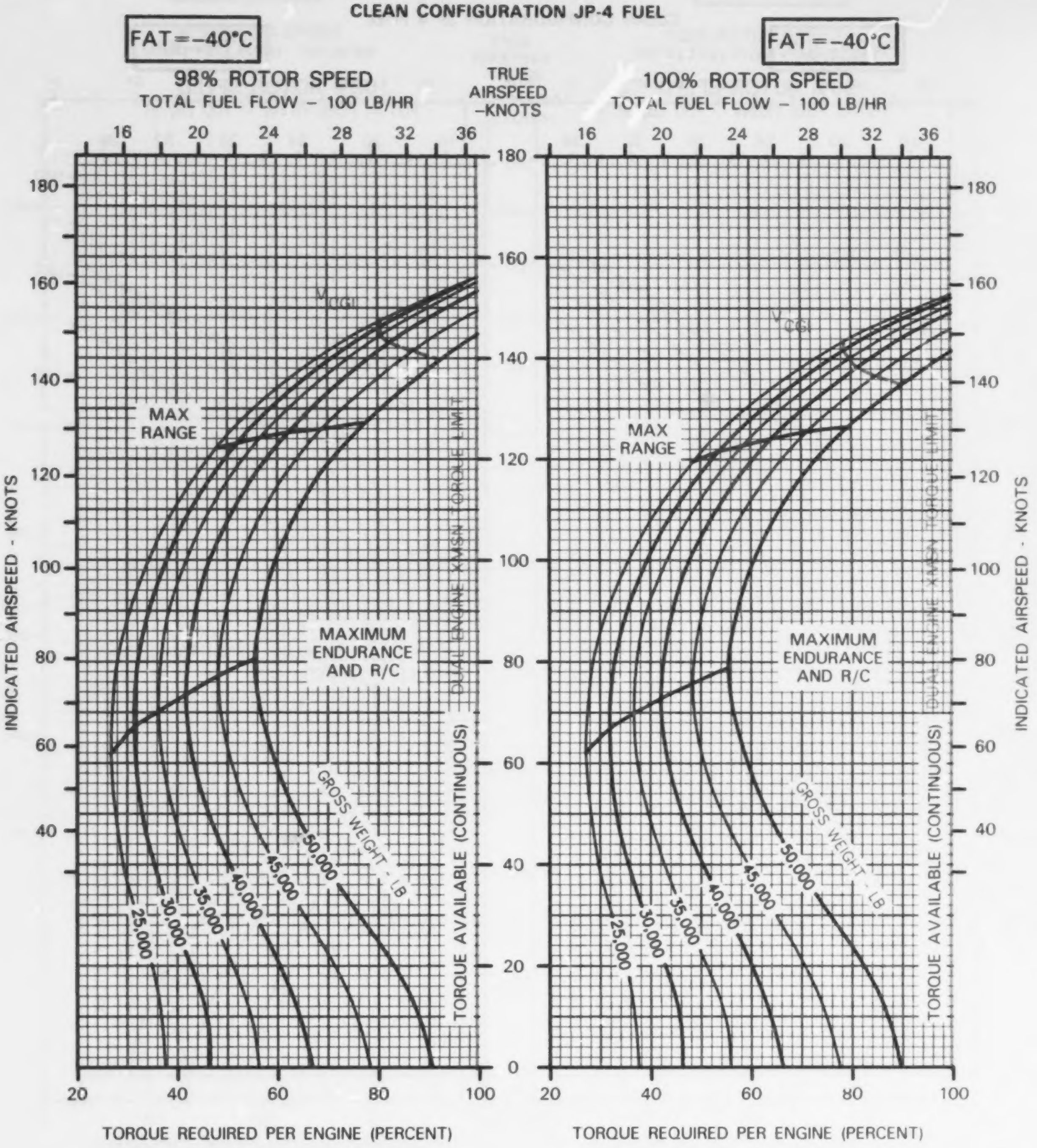
Figure 7-20. 98 and 100% Rotor RPM, -50°C, 4,000 Feet

R ■

CRUISE

PRESSURE ALTITUDE - 4000 FT

CLEAN CONFIGURATION JP-4 FUEL



R ■

A9126

DATA BASIS: FLIGHT TEST

Figure 7-20.1. 98 and 100% Rotor RPM, -40°C, 4,000 Feet

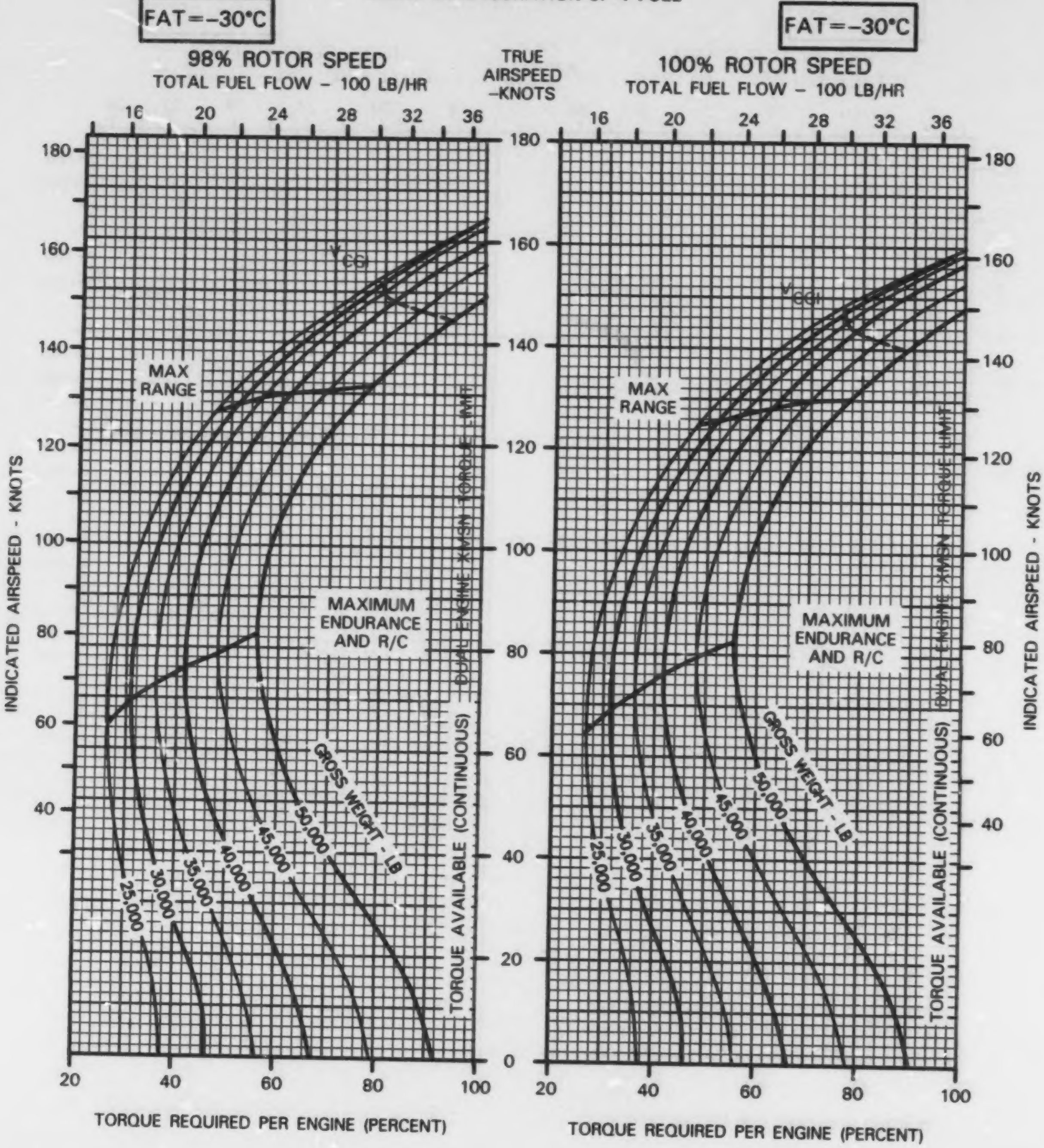
R ■

CRUISE

PRESSURE ALTITUDE - 4000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

R ■
A9127

Figure 7-20.2. 98 and 100% Rotor RPM, −30°C, 4,000 Feet

█ R
▨

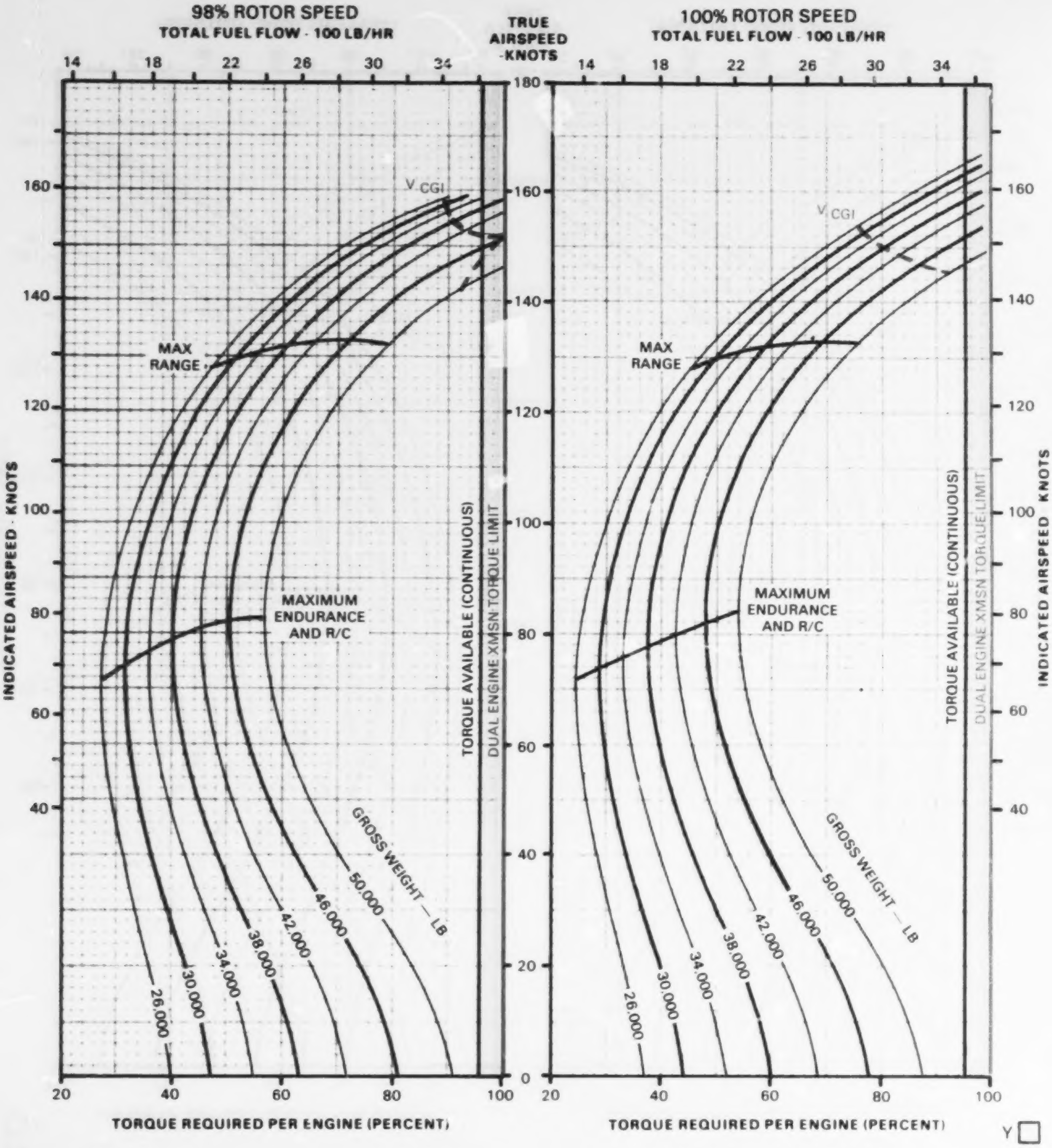
CRUISE
PRESSURE ALTITUDE — 4000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = −20°C

CLEAN CONFIGURATION JP-4 FUEL

FAT = −20°C



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

D145 223 10

Figure 7-21. 98 and 100% Rotor RPM, −20°C, 4,000 Feet

■ R

☐

CRUISE

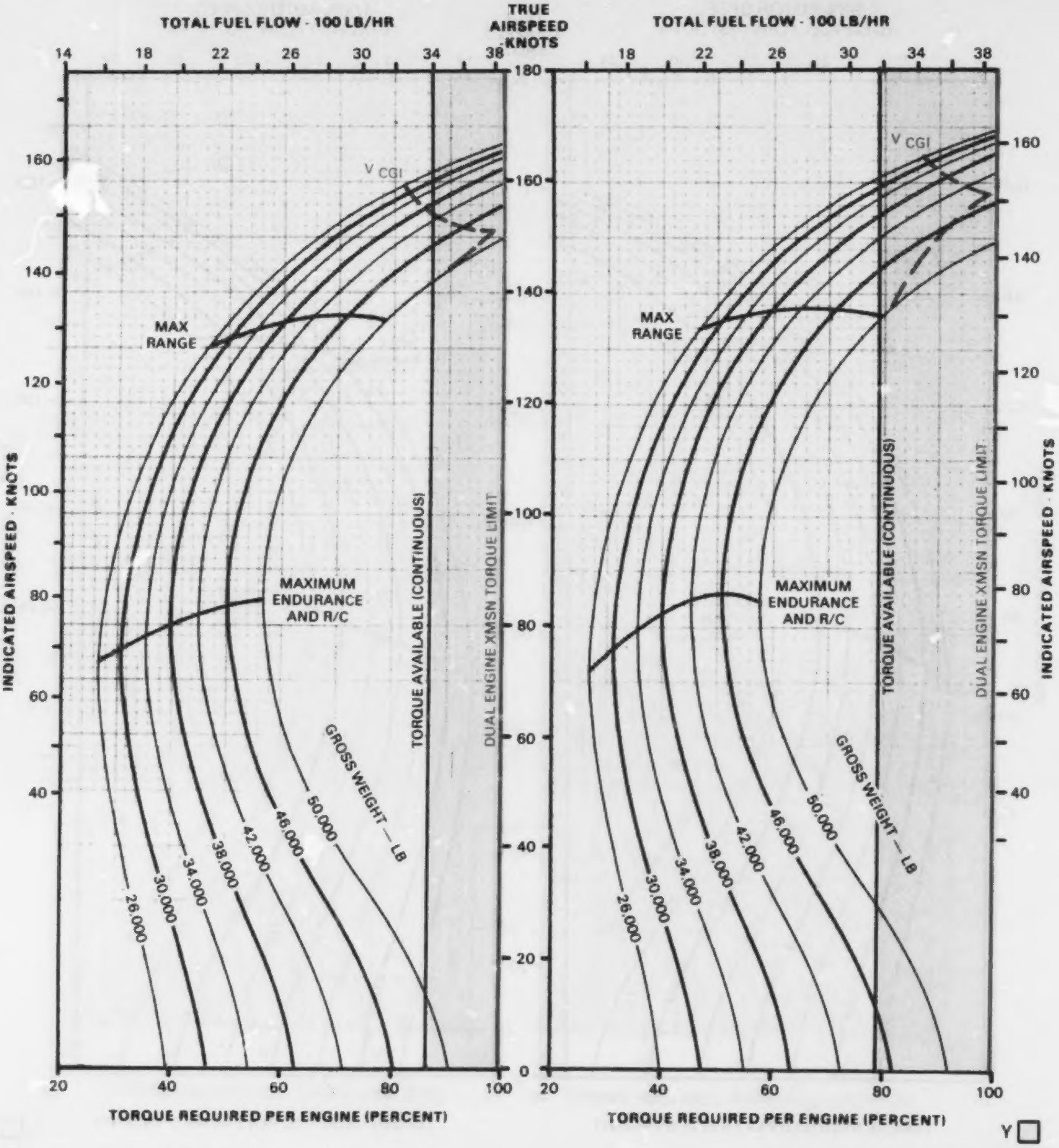
PRESSURE ALTITUDE — 4000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = -10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 0°C



DATA BASIS: FLIGHT TEST

Y ☐
R ■

D145-224-10

Figure 7-22. 100% Rotor RPM, -10° and 0°C, 4,000 Feet

■ R
☐

CRUISE

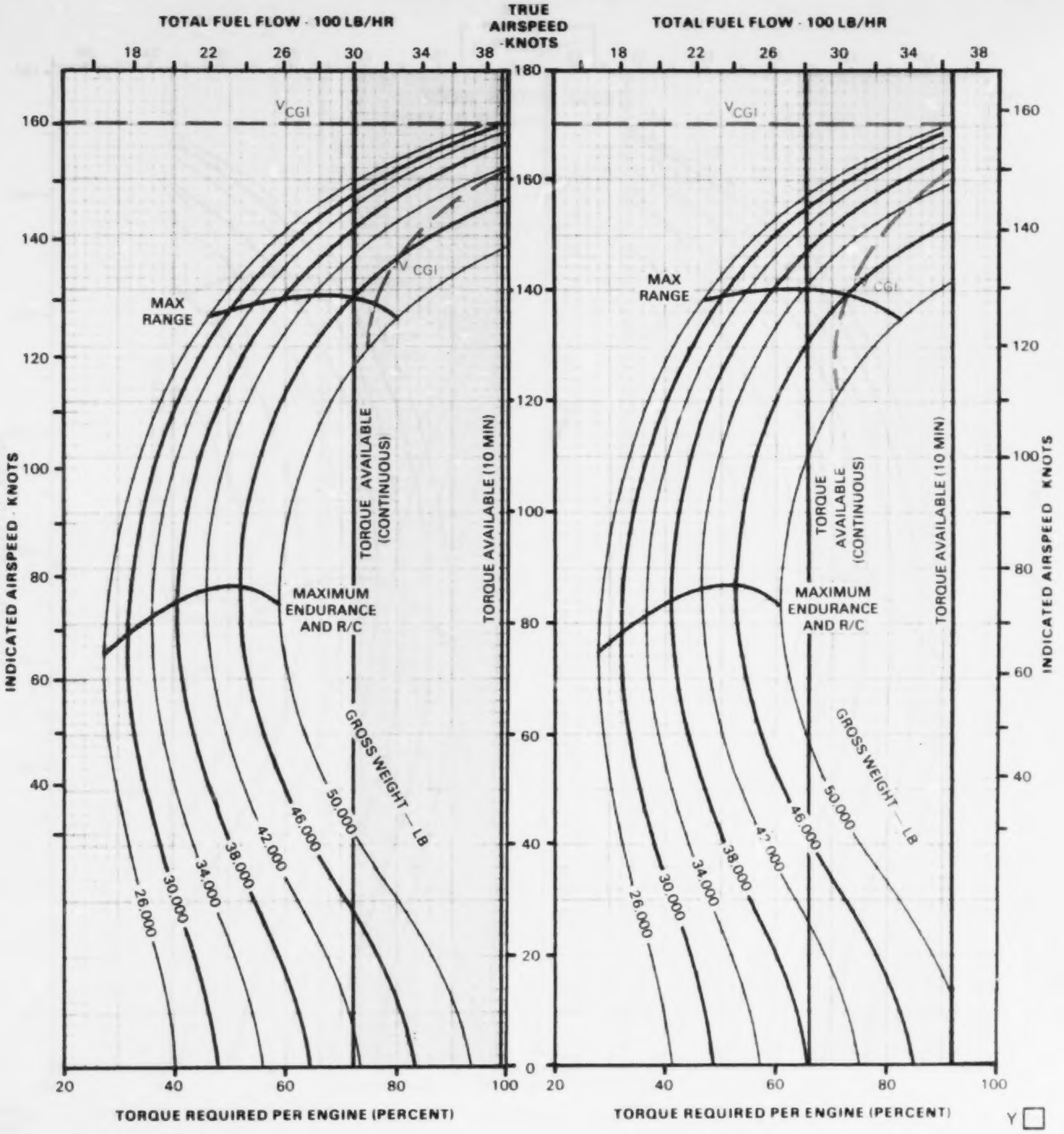
PRESSURE ALTITUDE — 4000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = 10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 20°C



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

D145 225 10

Figure 7-23. 100% Rotor RPM, 10° and 20°C, 4,000 Feet

■ R
☐

CRUISE

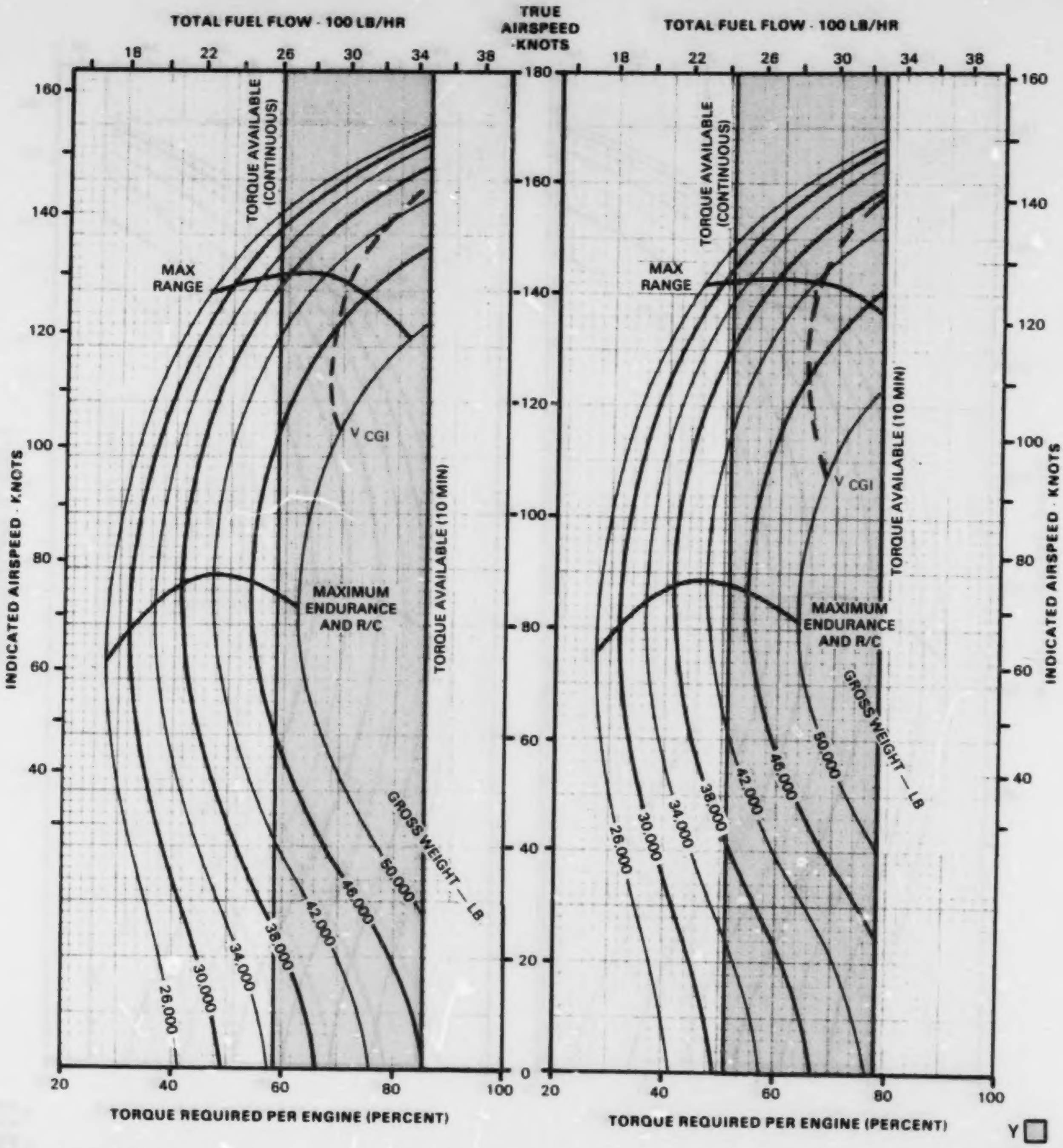
PRESSURE ALTITUDE — 4000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = 30°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 40°C



Y ☐
R ■

DATA BASIS: FLIGHT TEST

D145-226-10

Figure 7-24. 100% Rotor RPM, 30° and 40°C, 4,000 Feet

CRUISE
CH-47D
(2) T55-L-712

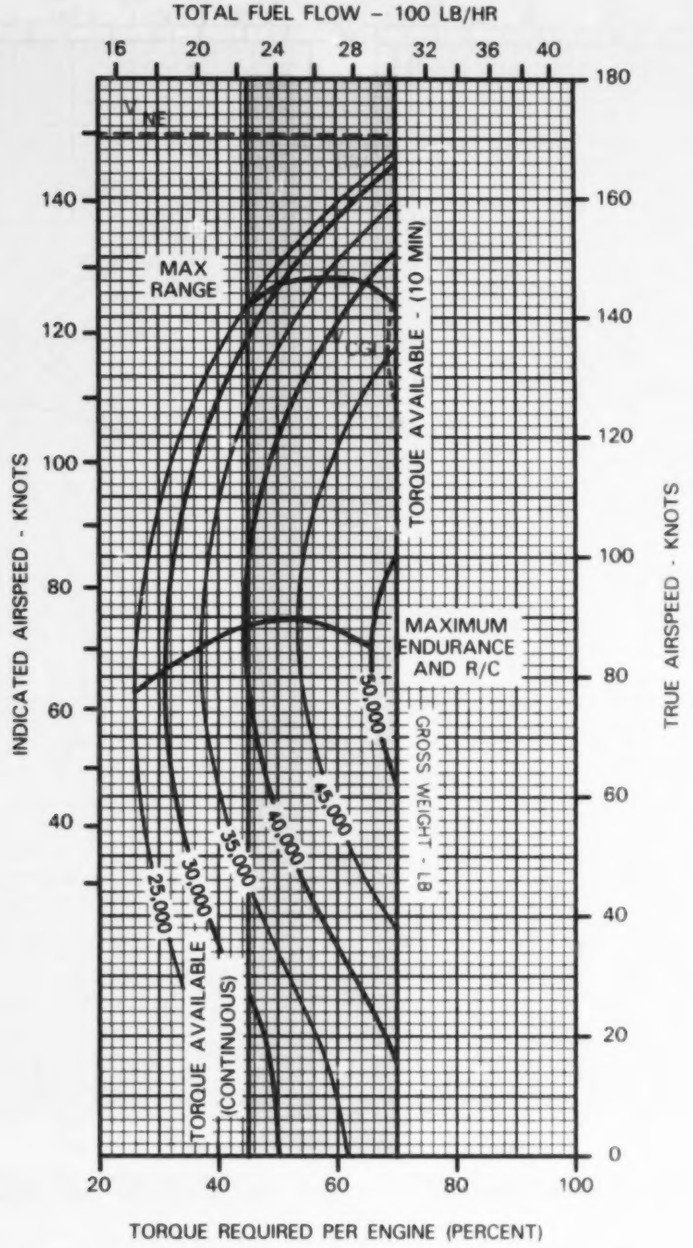
CRUISE

PRESSURE ALTITUDE - 4000 FT

CLEAN CONFIGURATION JP-4 FUEL

FAT=50°C

100% ROTOR SPEED



A9128

DATA BASIS: FLIGHT TEST

Figure 7-24.1. 100% Rotor RPM, 50°C, 4,000 Feet

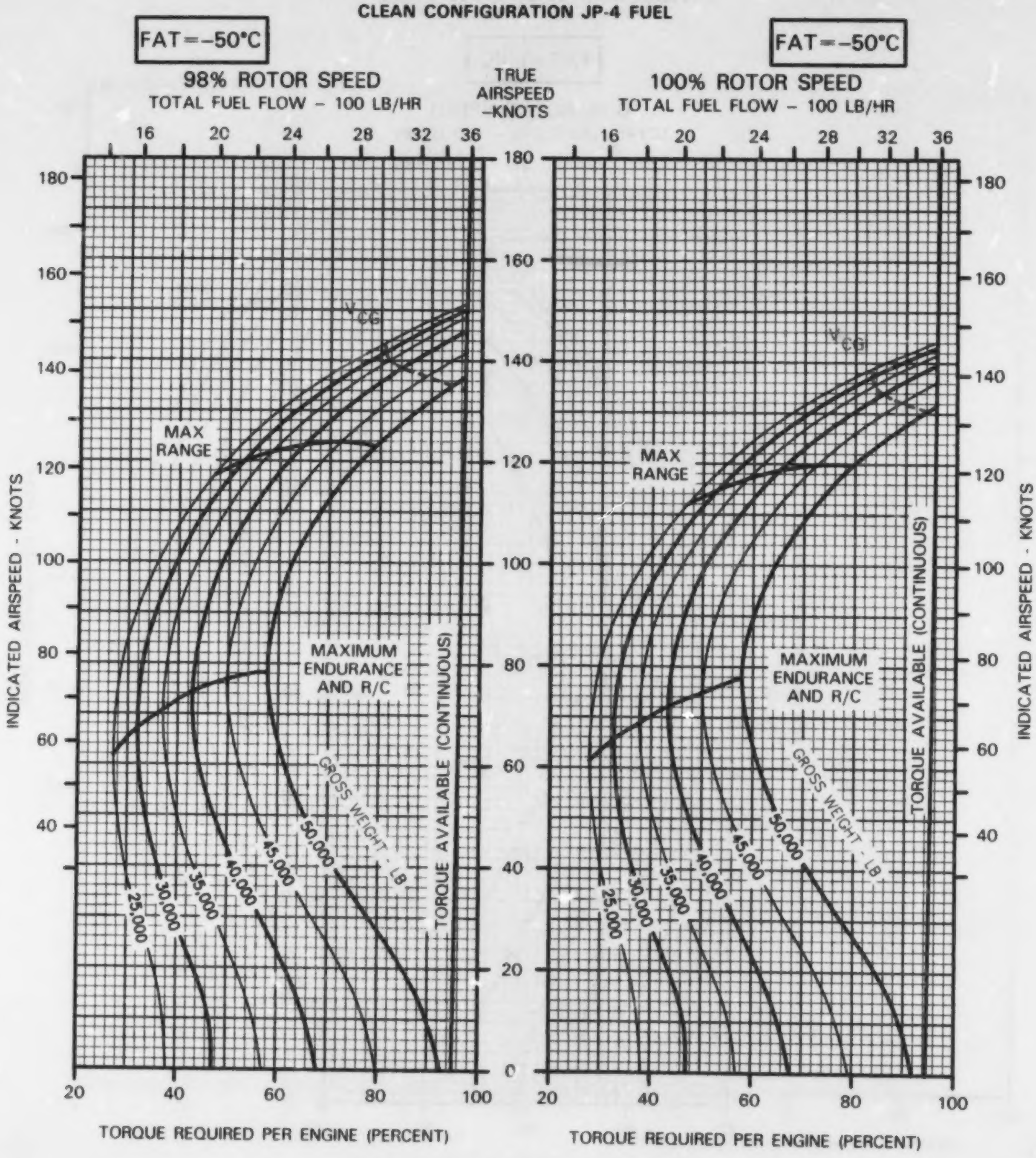
R ■

CRUISE

PRESSURE ALTITUDE - 6000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

R ■
A9134

Figure 7-25. 98 and 100% Rotor RPM, -50°C, 6,000 Feet

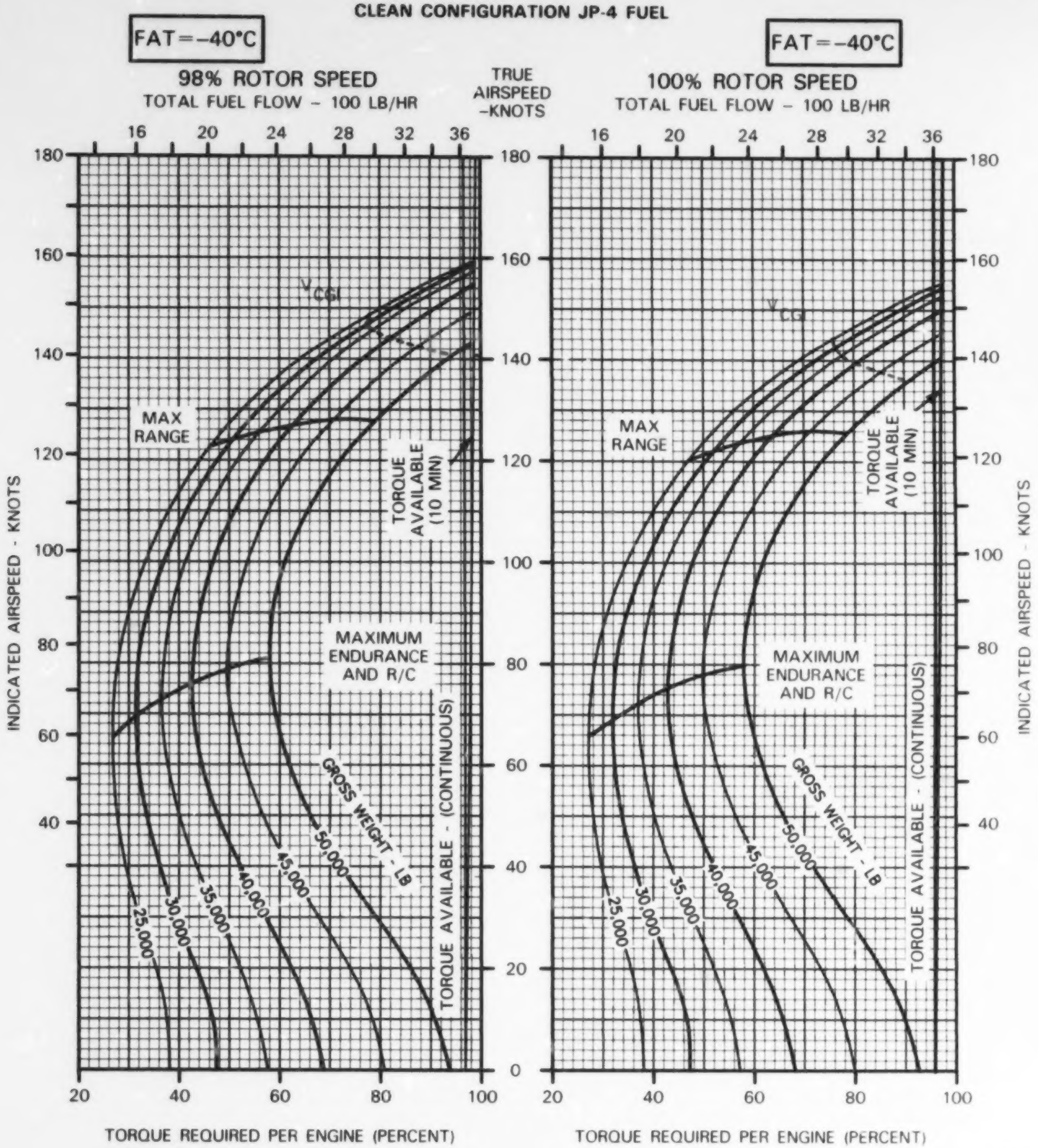
☐ Y
■ R

CRUISE

PRESSURE ALTITUDE - 6000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



Y ☐
R ■

DATA BASIS: FLIGHT TEST

A9135

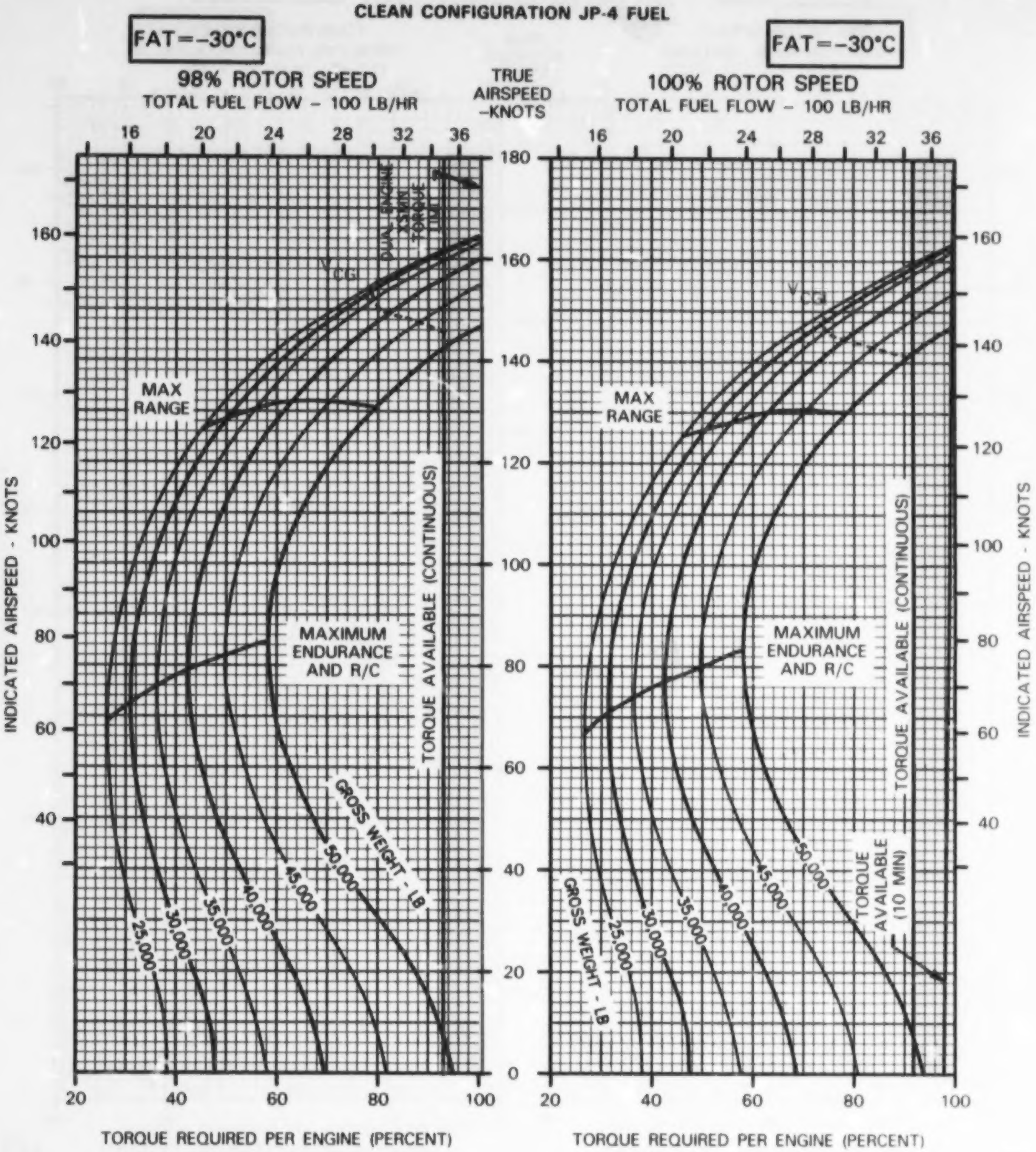
Figure 7-25.1. 98 and 100% Rotor RPM, −40°C, 6,000 Feet

▨
R ■

CRUISE
PRESSURE ALTITUDE - 6000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



▢
R ▨
A9276

DATA BASIS: FLIGHT TEST

Figure 7-25.2. 98 and 100% Rotor RPM, -30°C, 6,000 Feet

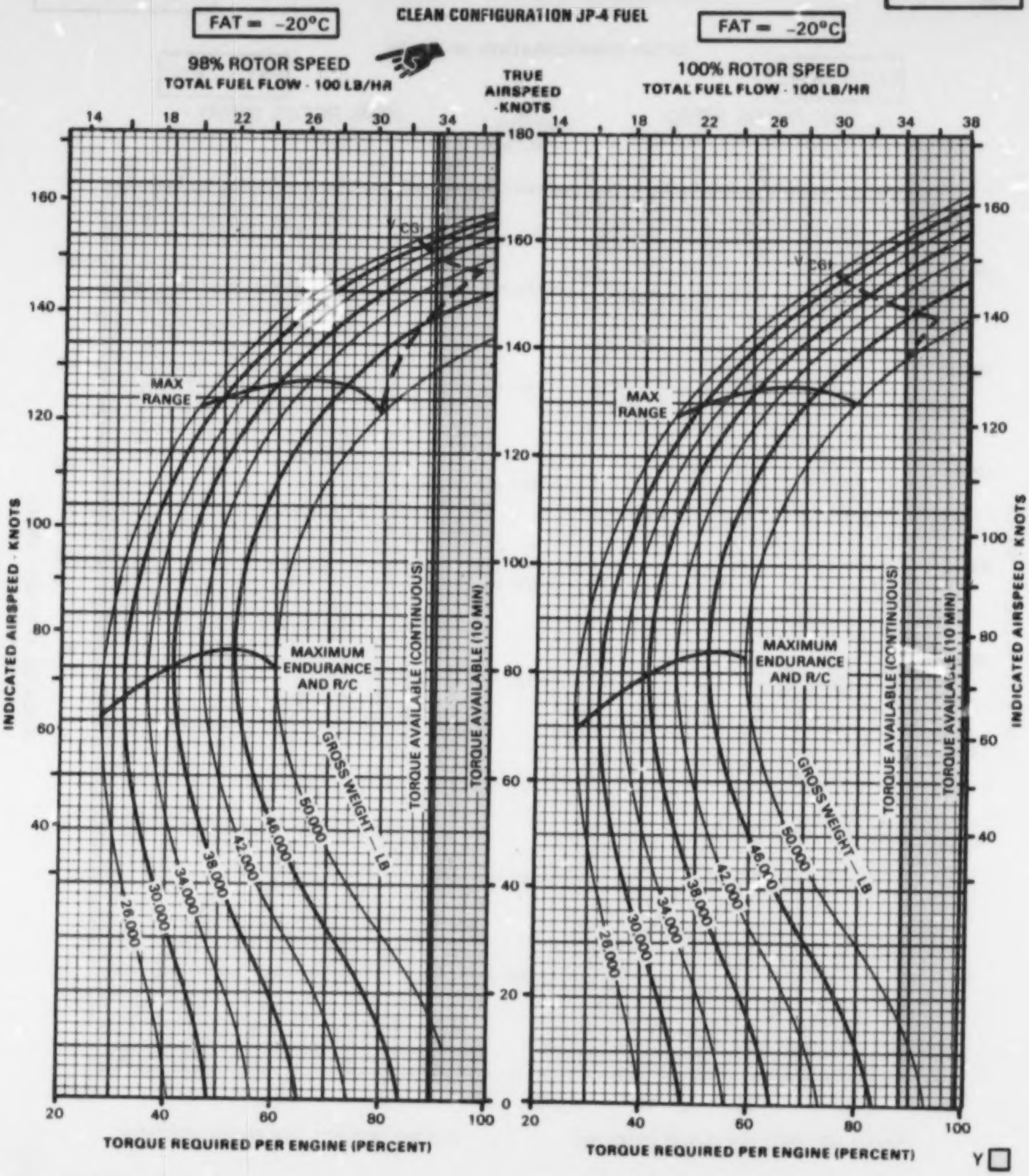
■ R
□

CRUISE

PRESSURE ALTITUDE — 6000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

Y □
R ■

D145-228-10

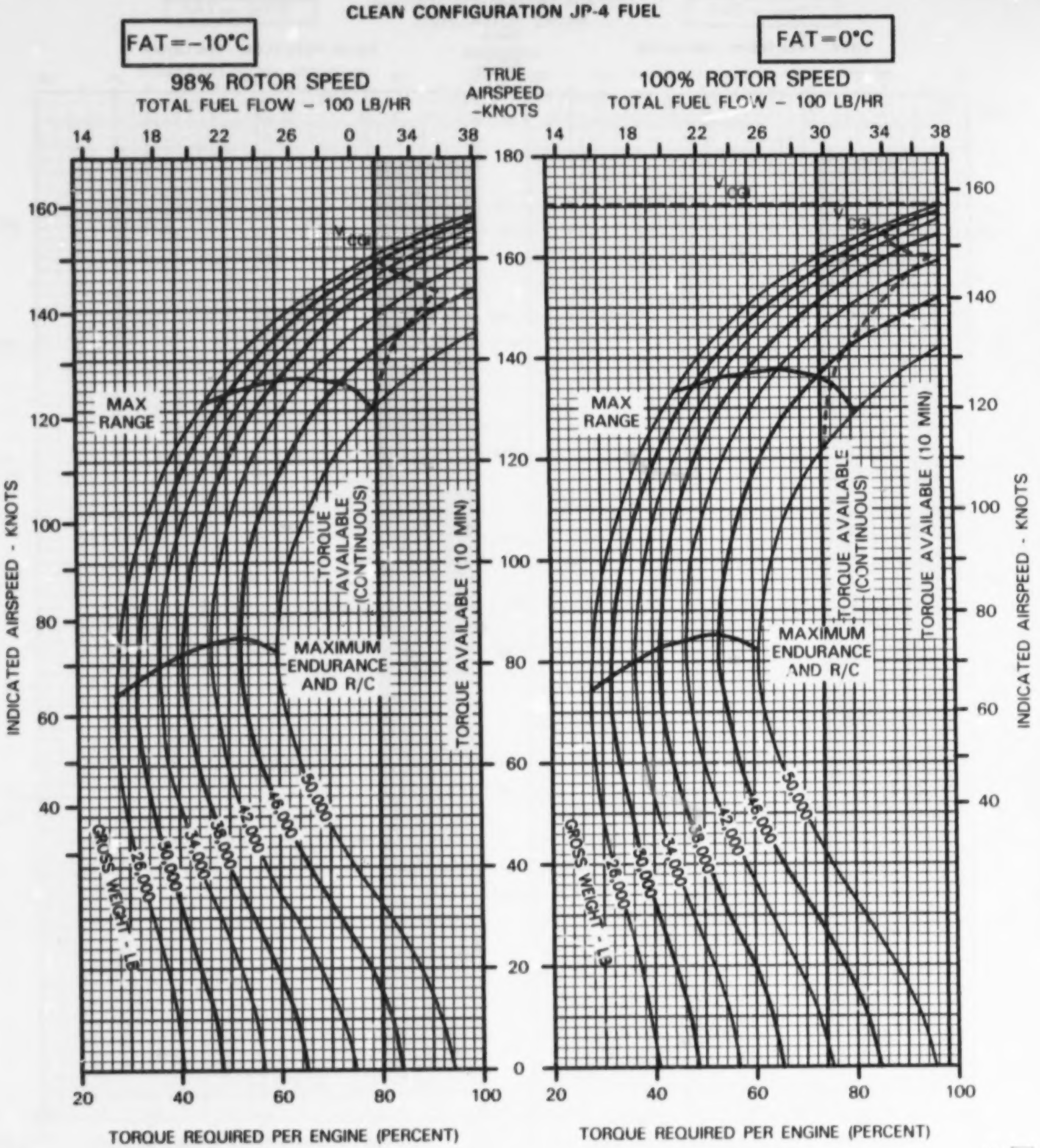
Figure 7-26. 98 and 100% Rotor RPM, -20°C, 6,000 Feet

Y ☐
R ■

CRUISE
CH-47D
(2) T55-L-712

CRUISE
PRESSURE ALTITUDE - 6,000 FT

CLEAN CONFIGURATION JP-4 FUEL



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

A11899

Figure 7-27. 100% Rotor RPM, -10° and 0°C, 6,000 Feet

■ R

☐

CRUISE

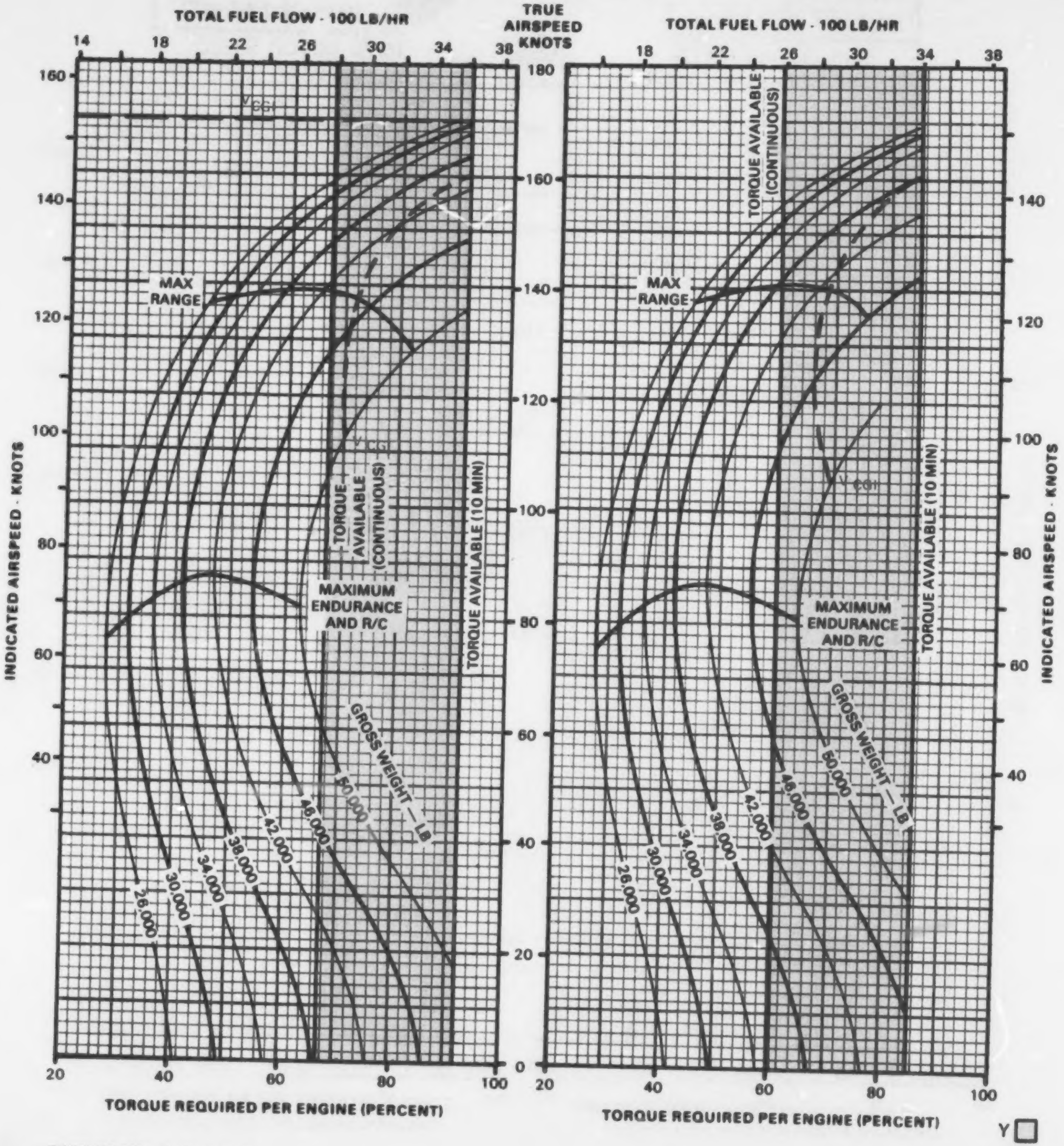
PRESSURE ALTITUDE — 6000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = 10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 20°C



Y ☐

R ■

DATA BASIS: FLIGHT TEST

Figure 7-28. 100% Rotor RPM, 10° and 20°C, 6,000 Feet

D146-230-10

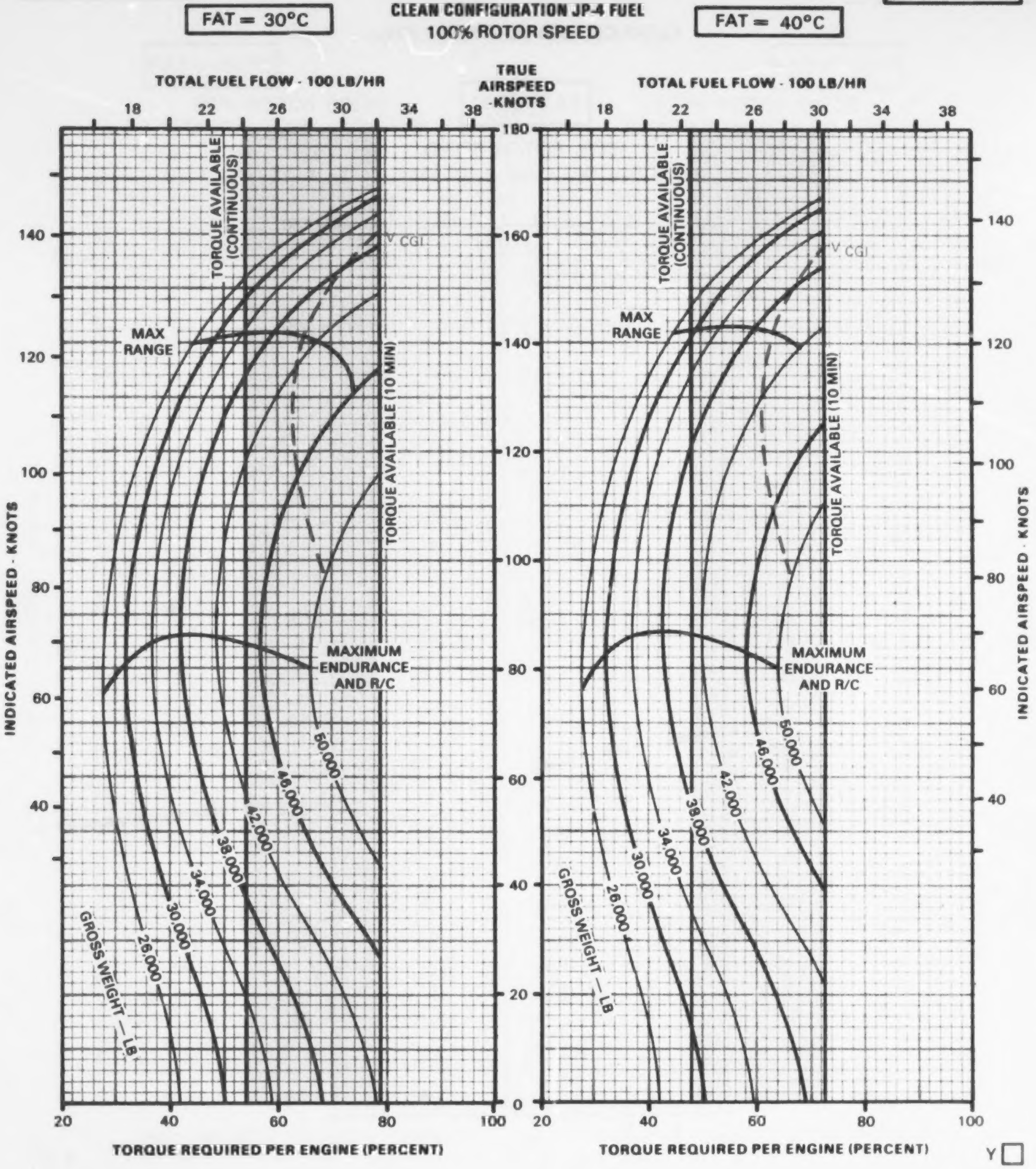
▇ R
☐ Y

CRUISE

PRESSURE ALTITUDE — 6000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

D145-231-10

Figure 7-29. 100% Rotor RPM, 30° and 40°C, 6,000 Feet

Y ☐

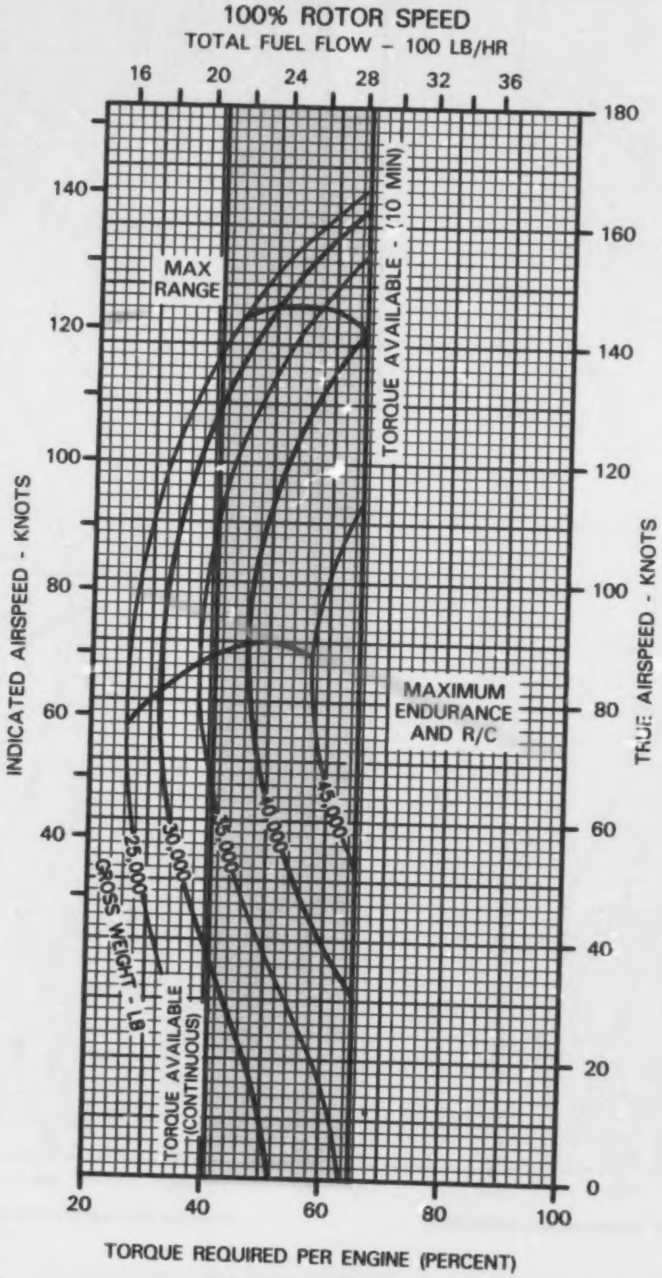
CRUISE

PRESSURE ALTITUDE - 6000 FT

CLEAN CONFIGURATION JP-4 FUEL

CRUISE
CH-47D
(2) T55-L-712

FAT=50°C



Y ☐

DATA BASIS: FLIGHT TEST

A9277

Figure 7-29.1. 100% Rotor RPM, 50°C, 6,000 Feet

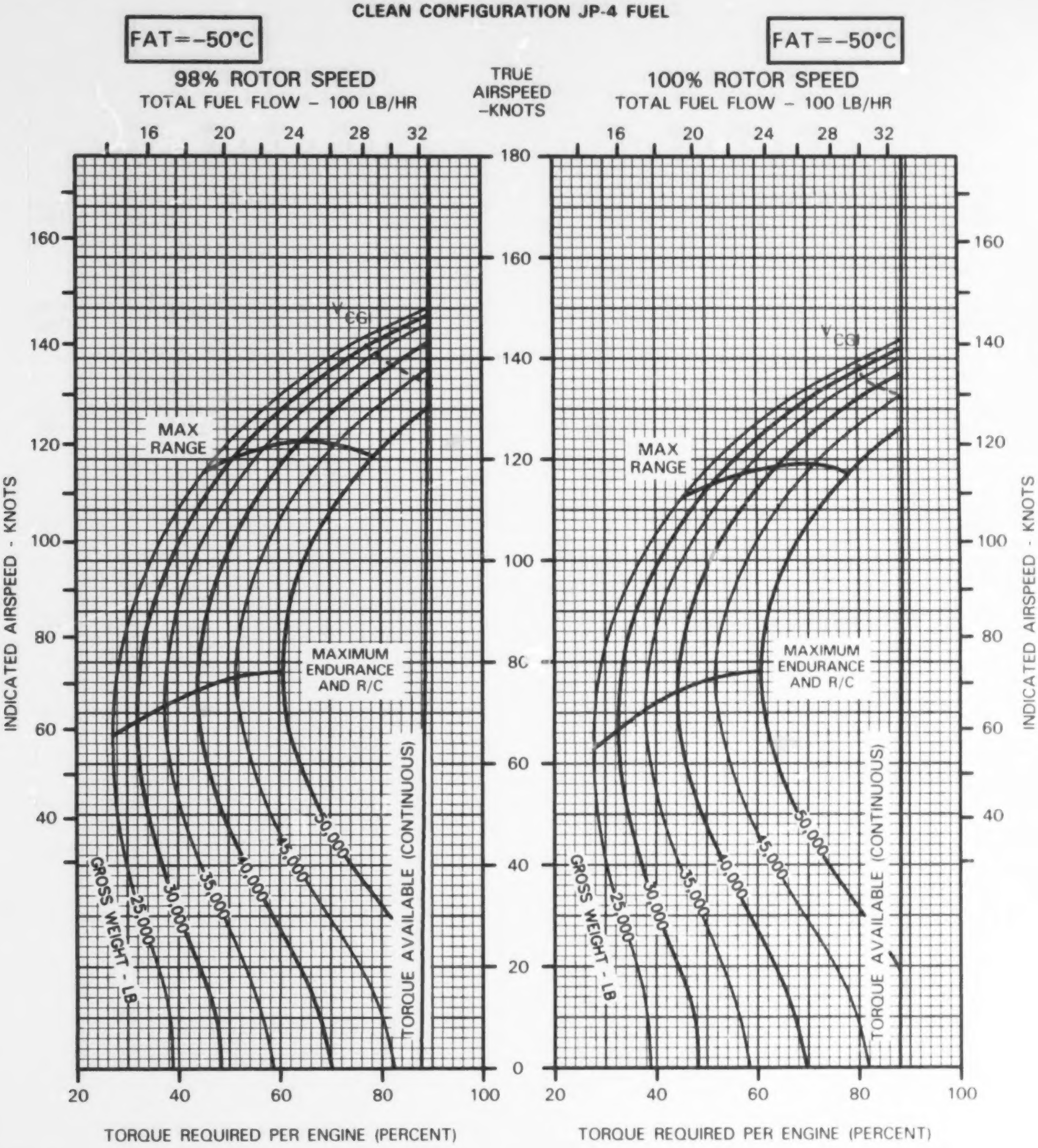
R ■

CRUISE

PRESSURE ALTITUDE - 8000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



R ■

A9407

DATA BASIS: FLIGHT TEST

Figure 7-30. 98 and 100% RPM, -50°C, 8,000 Feet

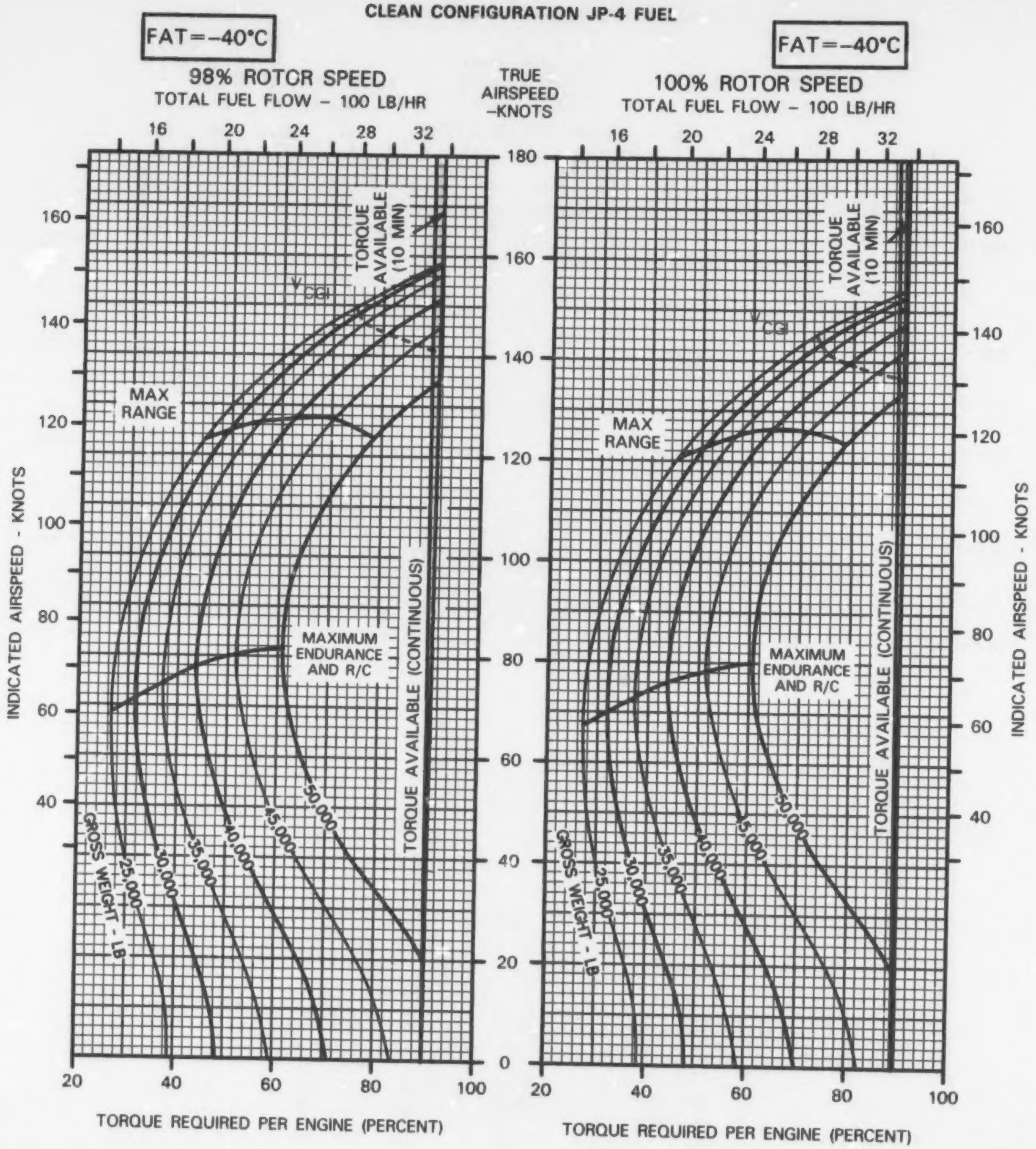
Y ☐
R ■

CRUISE

PRESSURE ALTITUDE - 8000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



Y ☐
R ■
A9278

DATA BASIS: FLIGHT TEST

Figure 7-30.1. 98 and 100% Rotor RPM, −40°C, 8,000 Feet

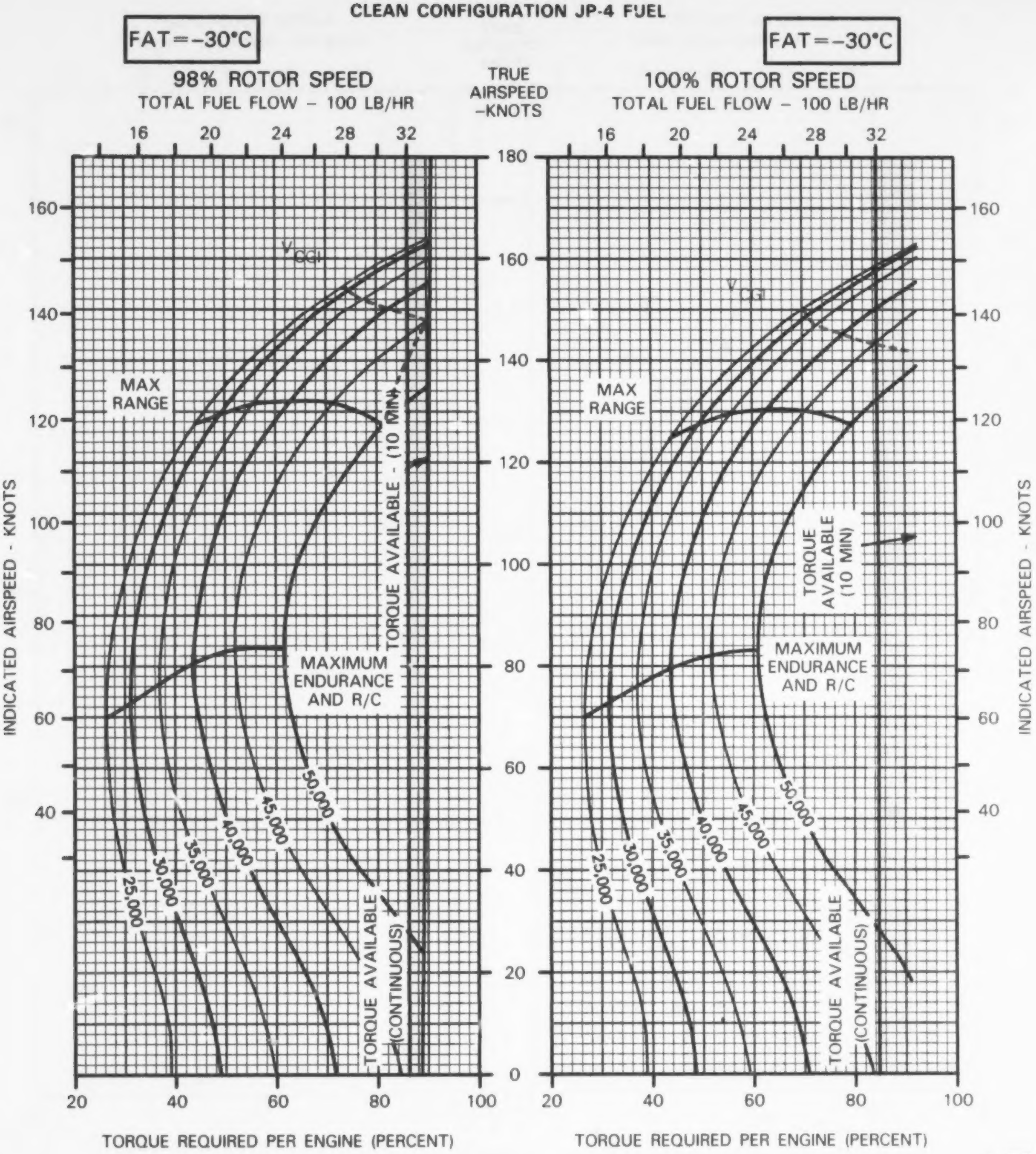
☐
■ R

CRUISE

PRESSURE ALTITUDE - 8000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

A9279

Figure 7-30.2. 98 and 100% Rotor RPM, -30°C, 8,000 Feet

■ R

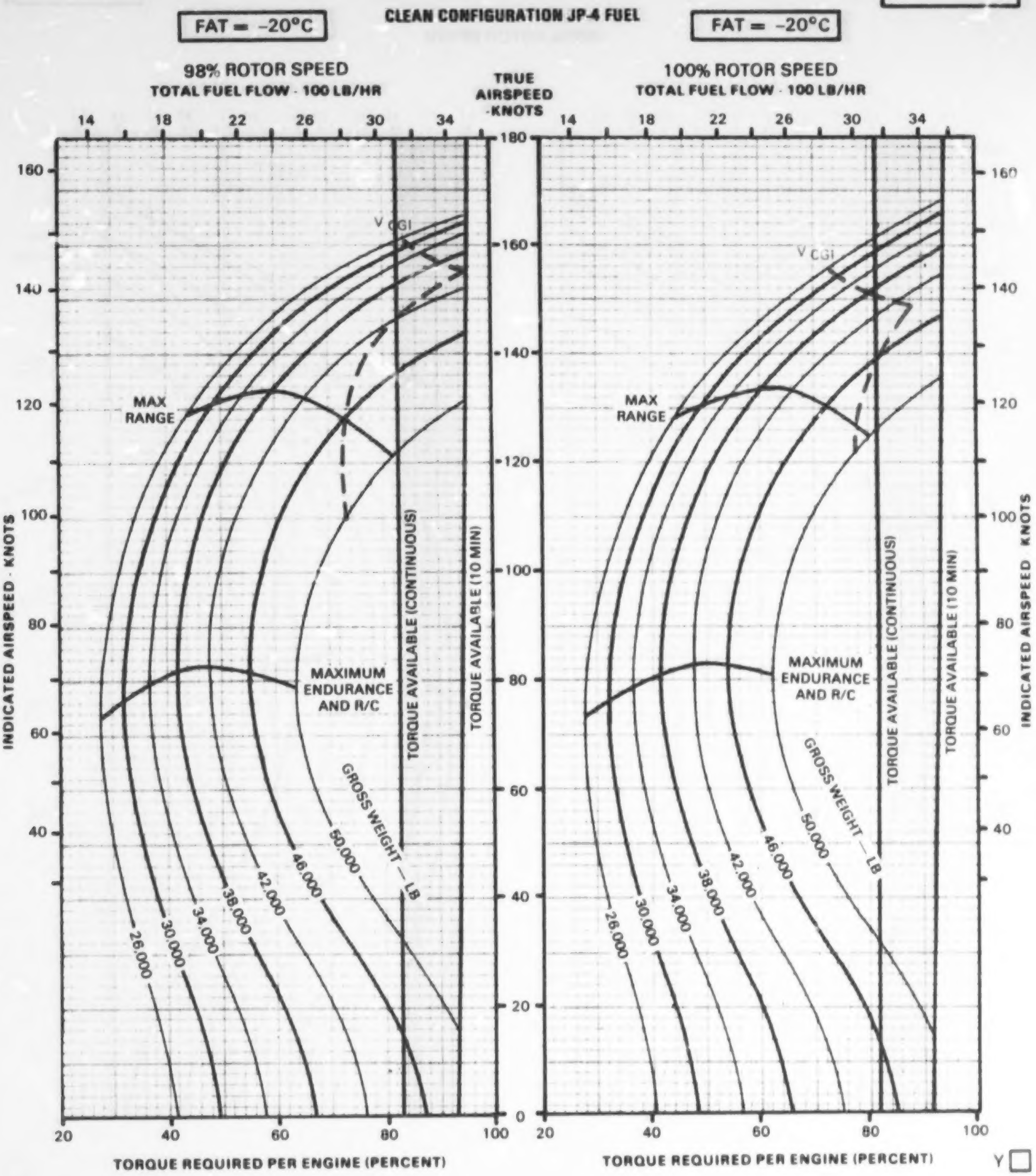
▨

CRUISE

PRESSURE ALTITUDE — 8000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

D145-233-10

Figure 7-31. 98 and 100% Rotor RPM, -20°C, 8,000 Feet

■ R
□

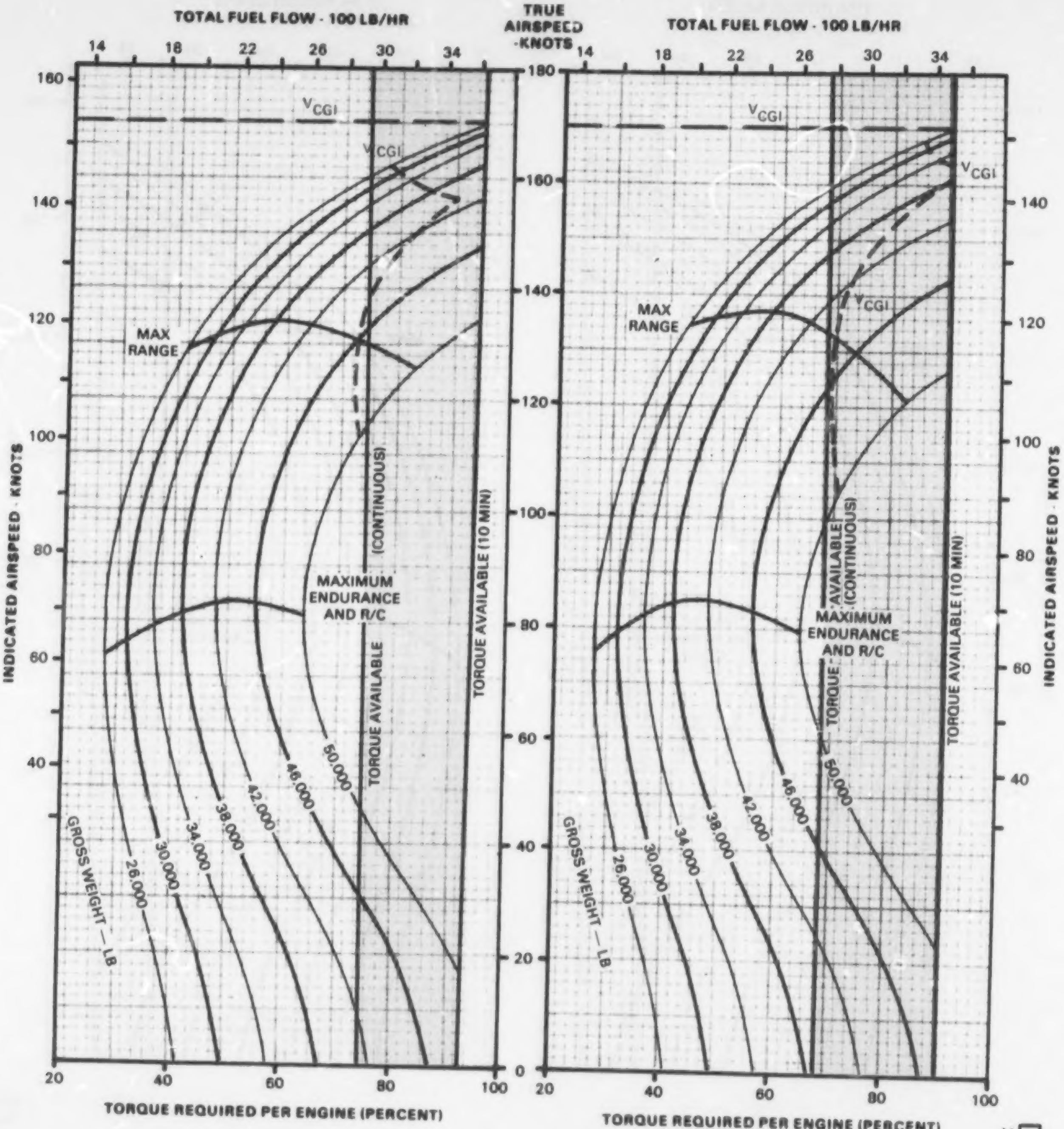
CRUISE
PRESSURE ALTITUDE — 8000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = -10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 0°C



Y □
R ■

DATA BASIS: FLIGHT TEST

D148-234-10

Figure 7-32. 100% Rotor RPM, -10° and 0°C, 8,000 Feet

■ R
☐

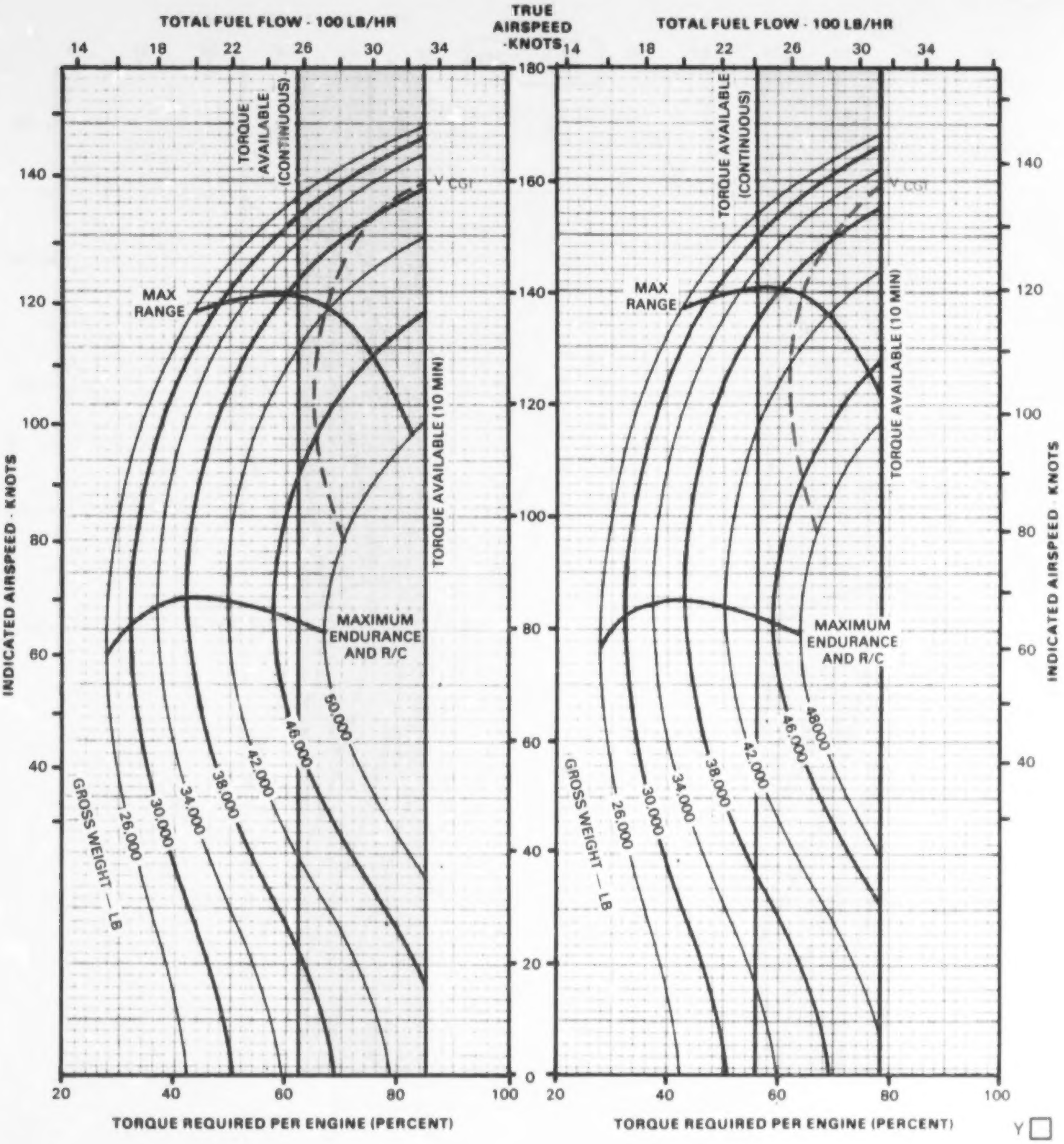
CRUISE
PRESSURE ALTITUDE — 8000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = 10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 20°C



Y ☐
R ▨

D145 235 10

DATA BASIS: FLIGHT TEST

Figure 7-33. 100% Rotor RPM, 10° and 20°C, 8,000 Feet

■ R

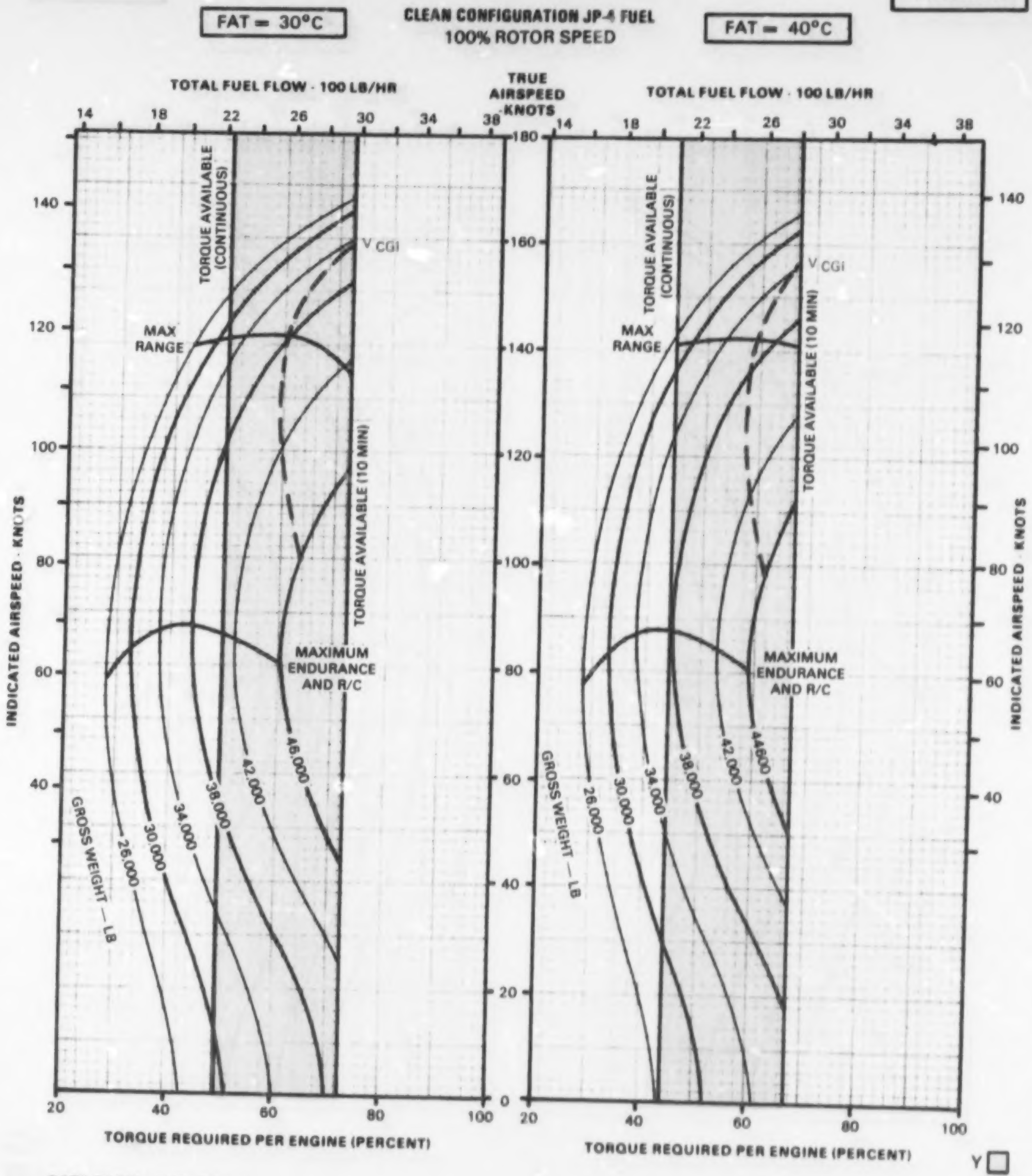
☐

CRUISE

PRESSURE ALTITUDE — 8000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED



DATA BASIS: FLIGHT TEST

Y ☐

R ■

D148-236-10

Figure 7-34. 100% Rotor RPM, 30° and 40°C, 8,000 Feet

Y ☐

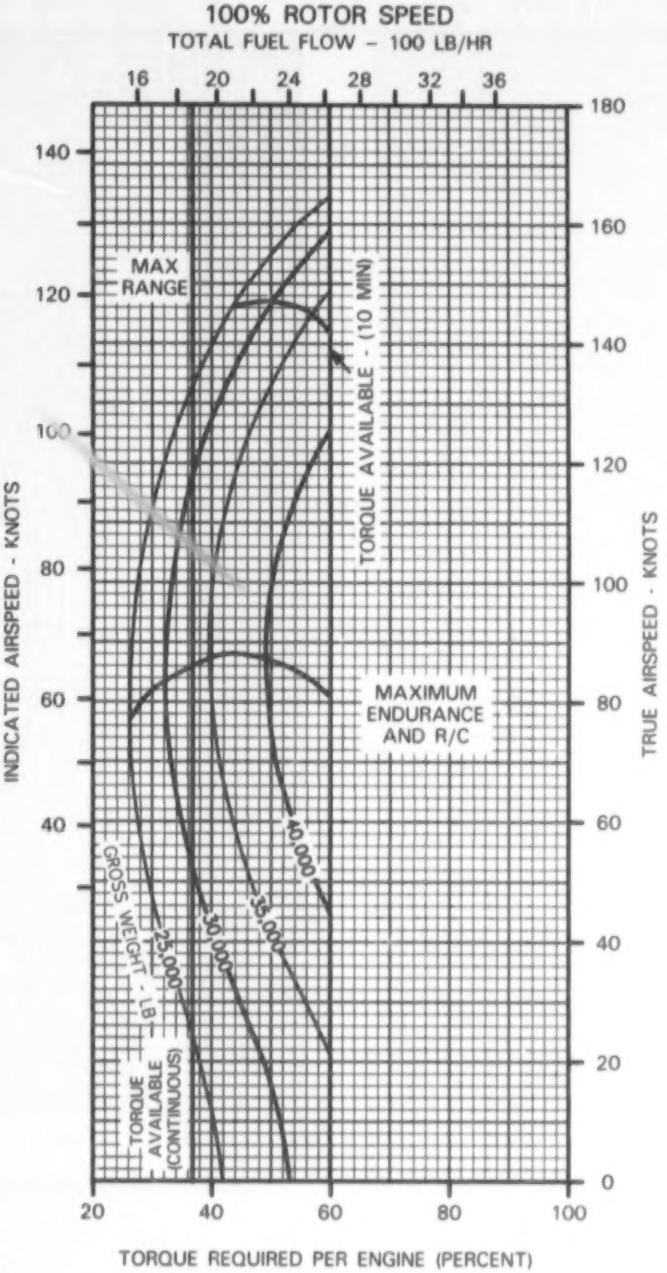
CRUISE

PRESSURE ALTITUDE - 8000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL

FAT=50°C



Y ☐

DATA BASIS: FLIGHT TEST

A9280

Figure 7-34.1. 100% Rotor RPM, 50°C, 8,000 Feet

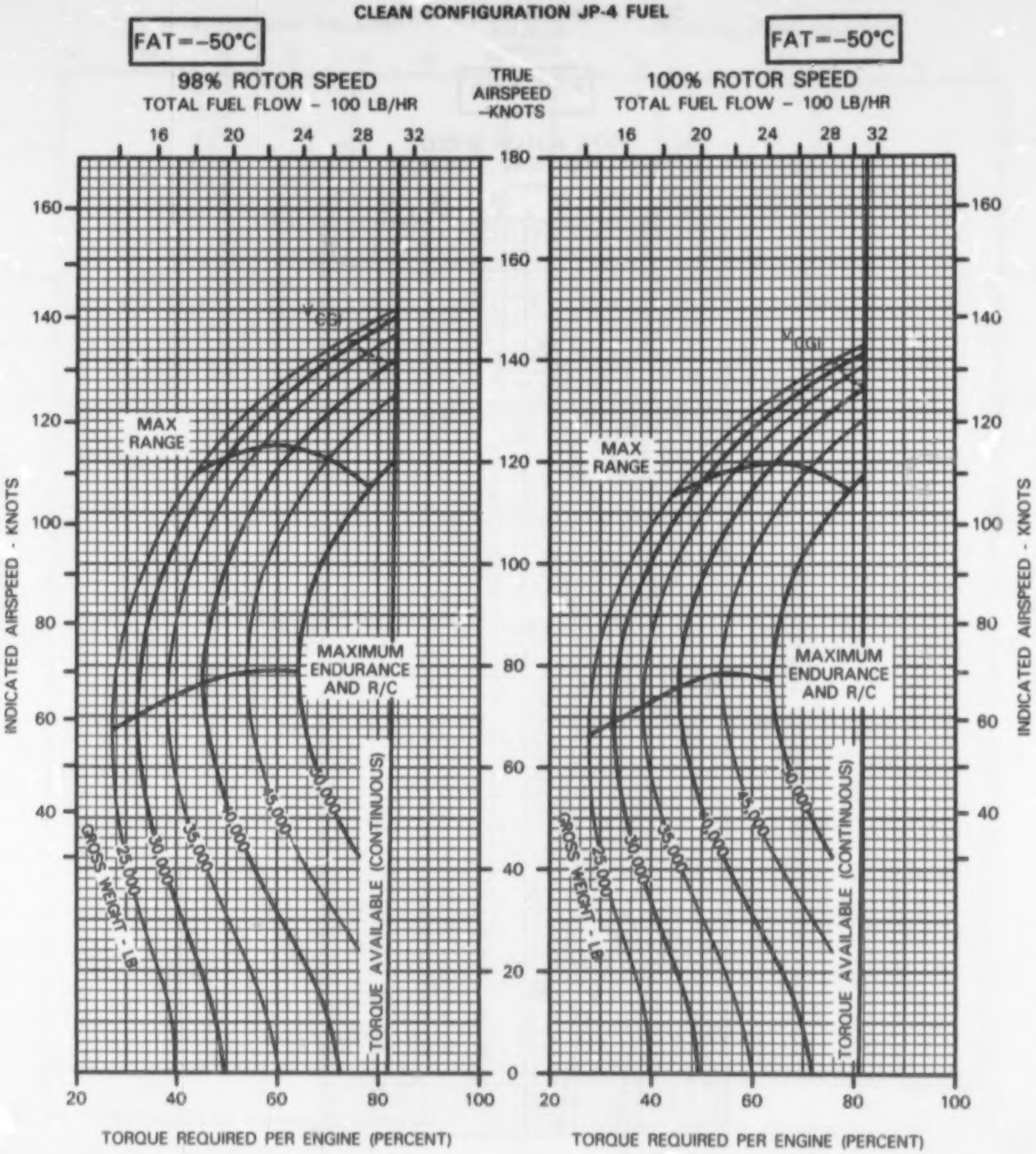
R

CRUISE

PRESSURE ALTITUDE - 10,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

R
A9372

Figure 7-35. 98 and 100% Rotor RPM, -50°C, 10,000 Feet

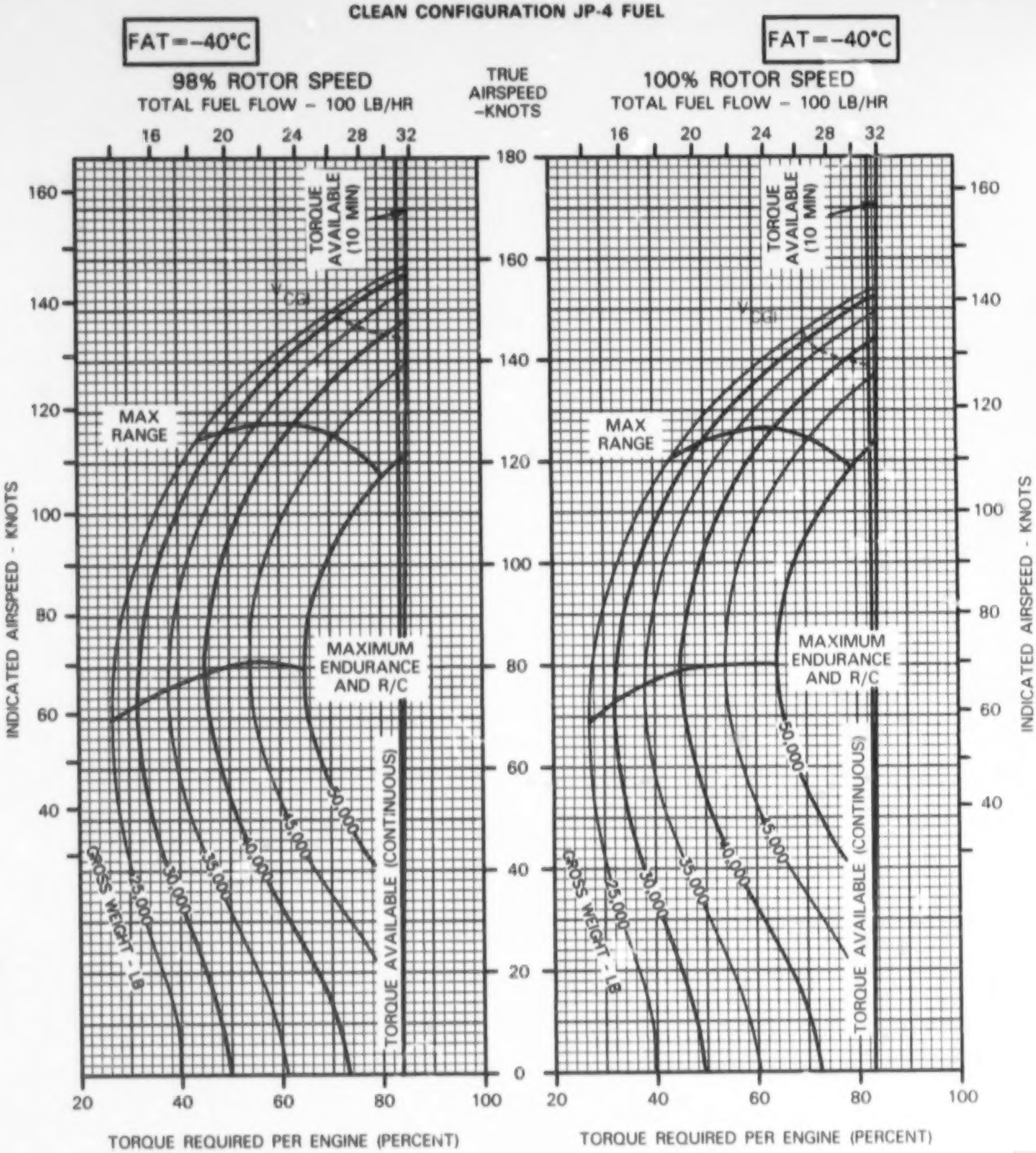
☐
R ■

CRUISE

PRESSURE ALTITUDE - 10,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



☐
R ■

A9373

DATA BASIS: FLIGHT TEST

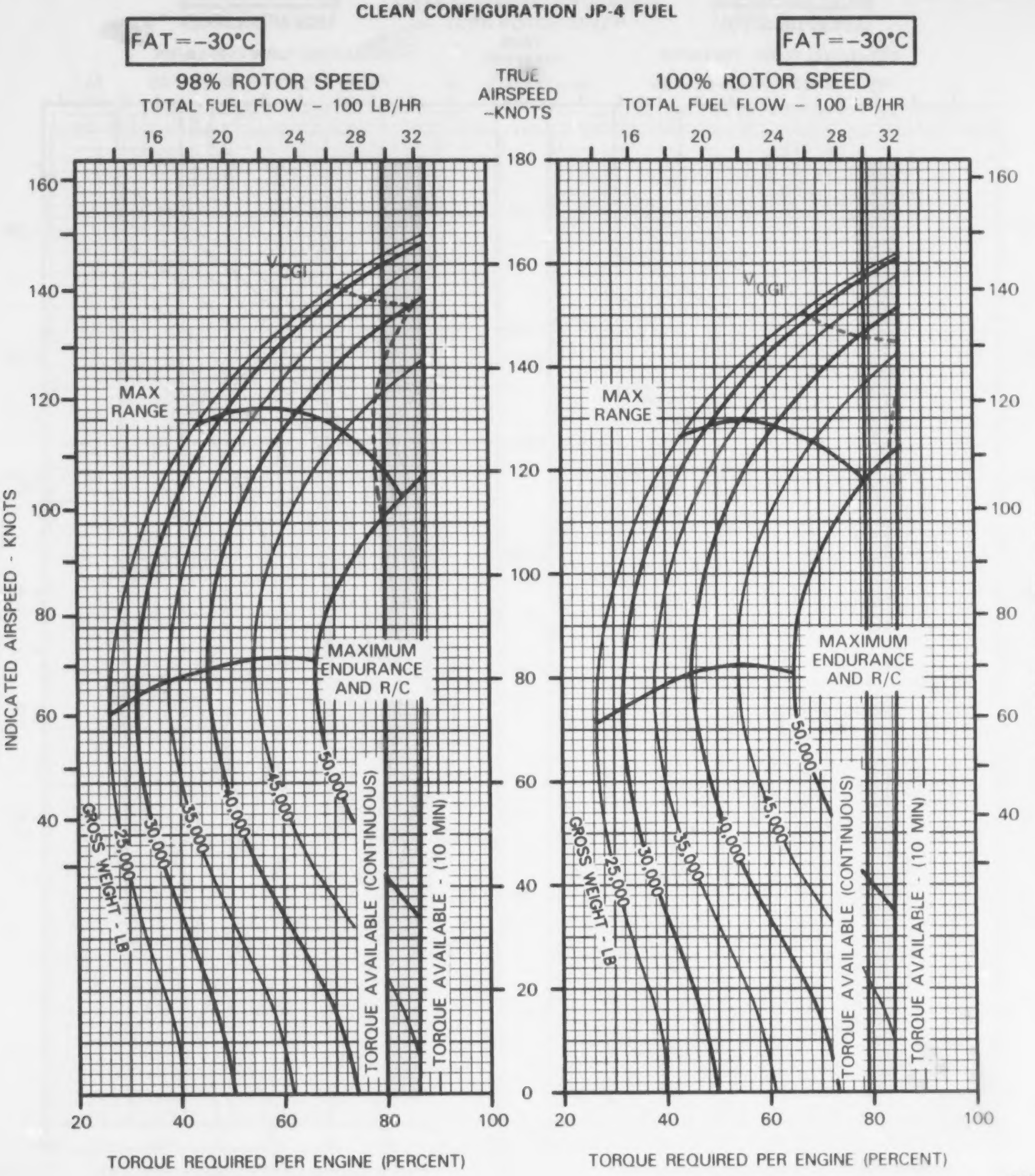
Figure 7-35.1. 98 and 100% Rotor RPM, -40°C, 10,000 Feet

▨
■ R

CRUISE
PRESSURE ALTITUDE - 10,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



Y □
R ▨
A9374

DATA BASIS: FLIGHT TEST

Figure 7-35.2. 98 and 100% Rotor RPM, -30°C, 10,000 Feet

■ R

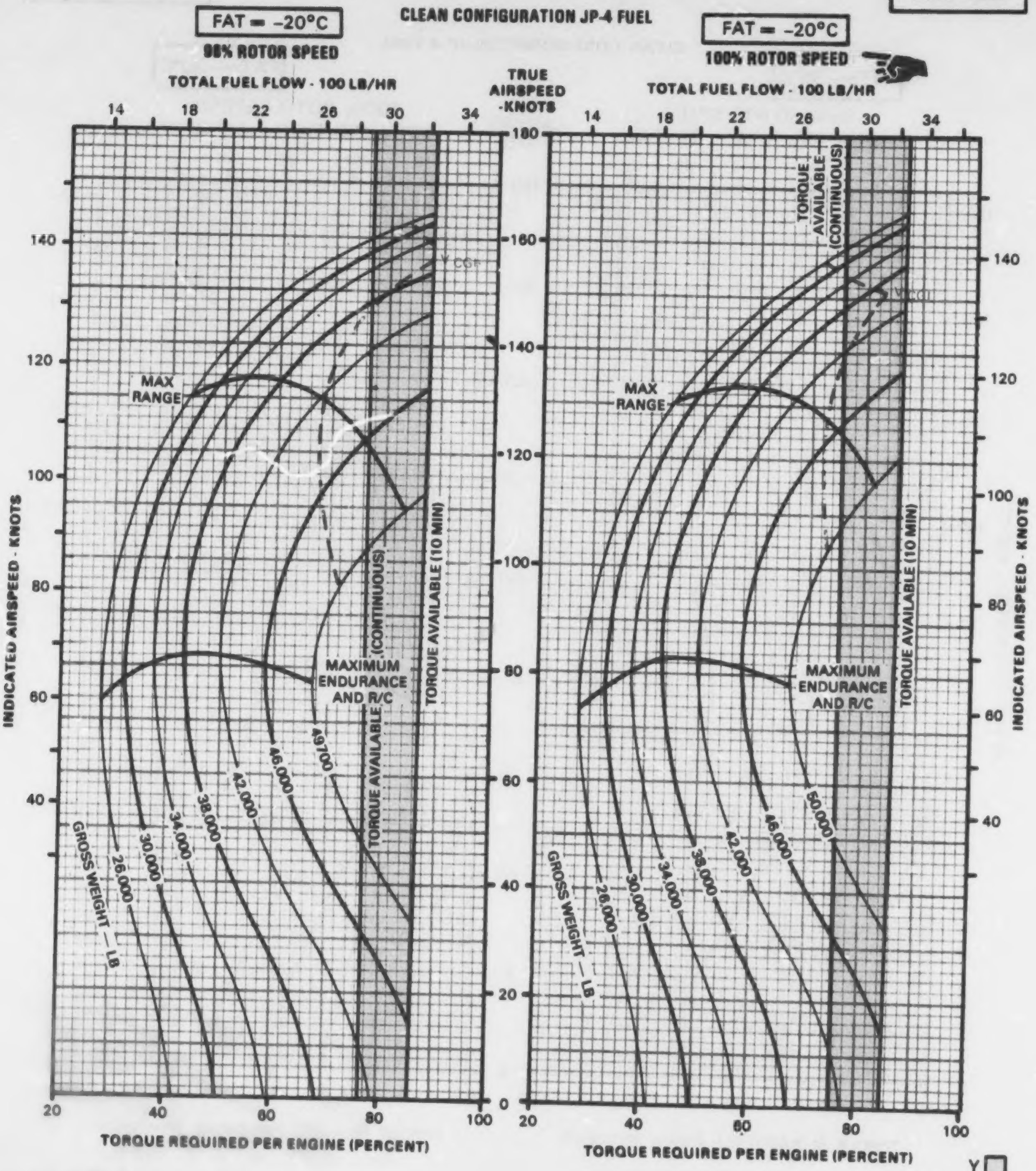
☐

CRUISE

PRESSURE ALTITUDE — 10,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

Y ☐

R ■

D145-238-10

Figure 7-36. 98 and 100% Rotor RPM, -20°C, 10,000 Feet

■ R

☐ Y

CRUISE
CH-47D
(2) T55-L-712

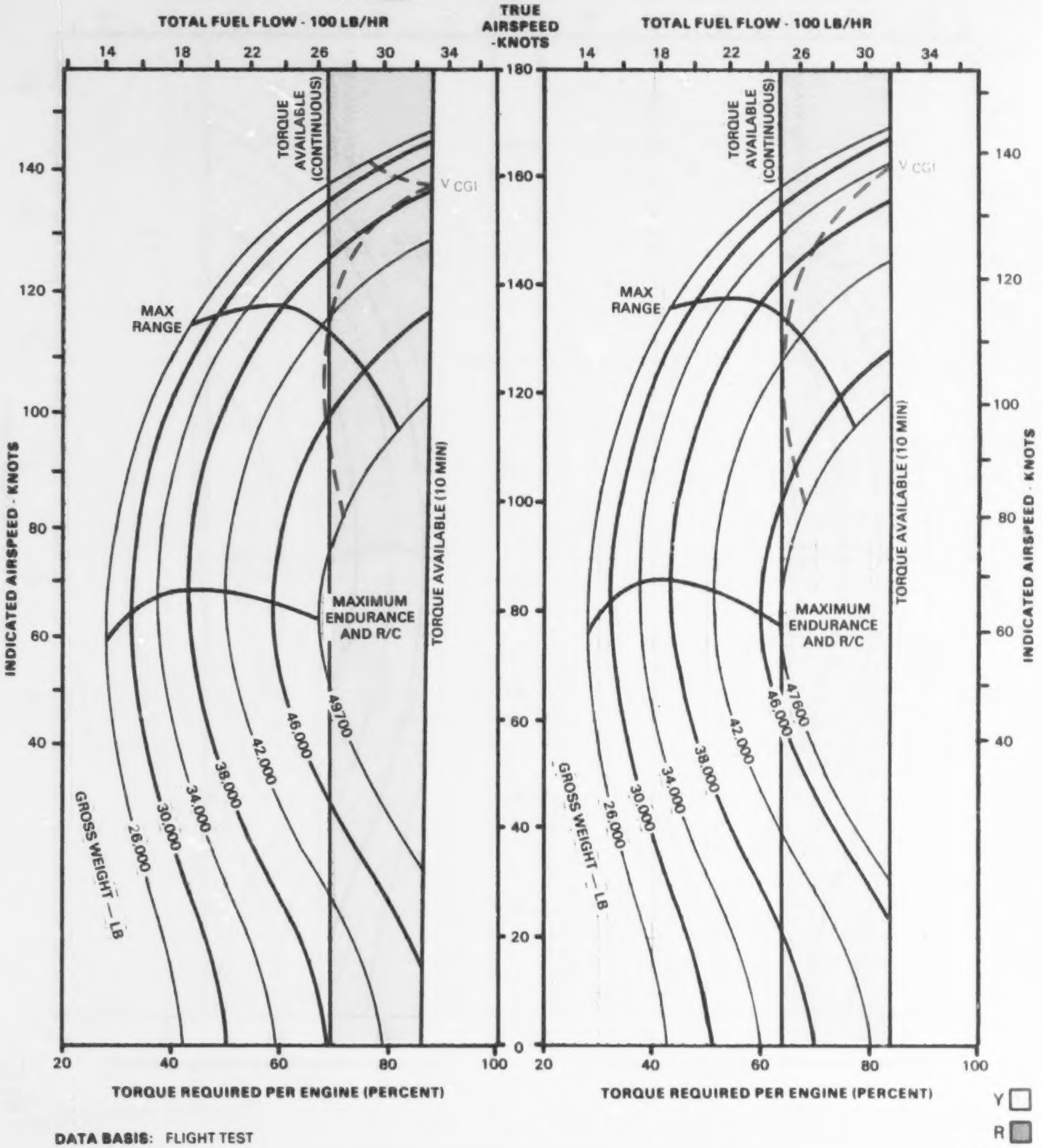
CRUISE

PRESSURE ALTITUDE — 10,000 FT

FAT = -10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 0°C



DATA BASIS: FLIGHT TEST

D145-239-10

Figure 7-37. 100% Rotor RPM, -10° and 0° C, 10,000 Feet

■ R

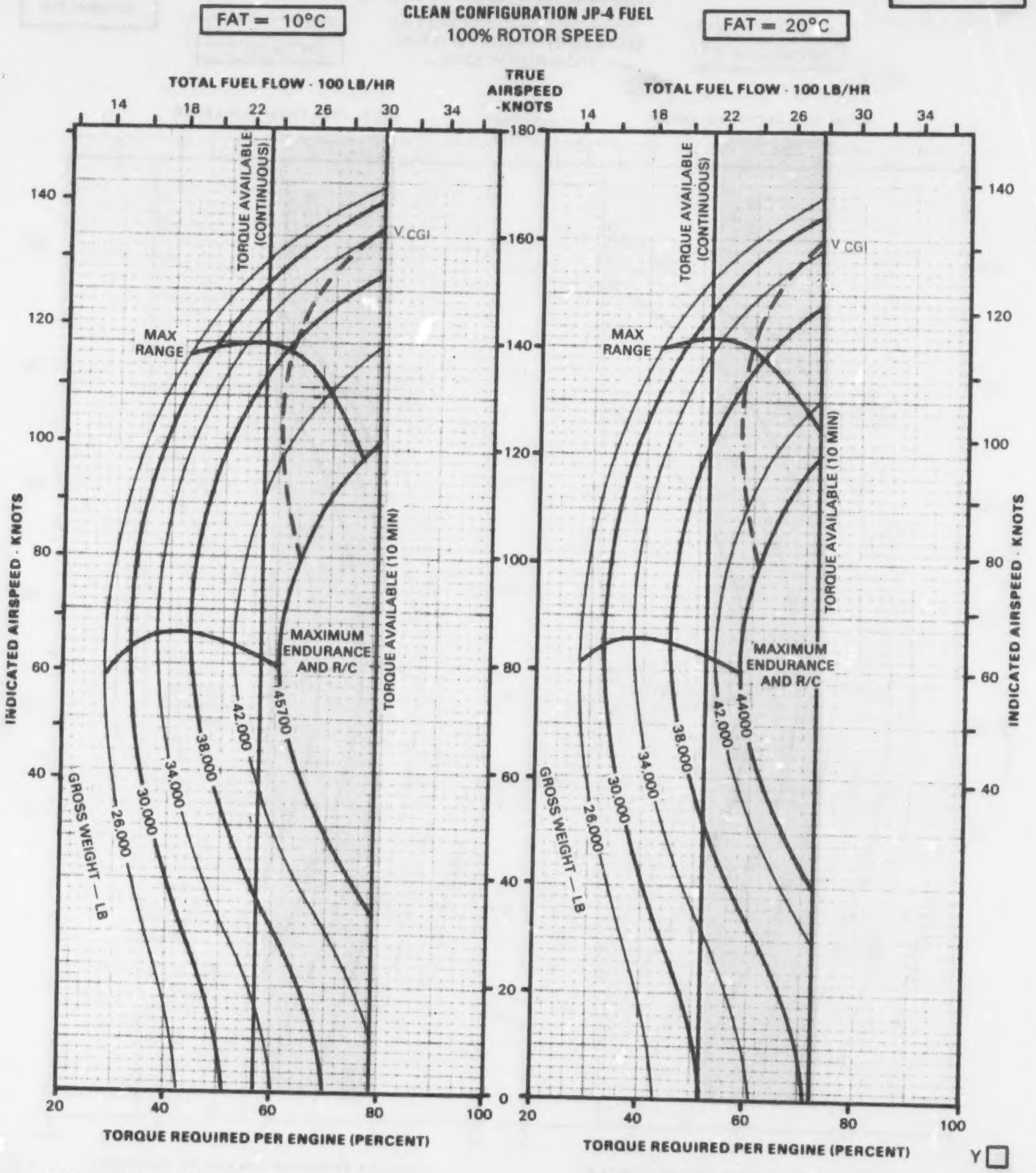
☐

CRUISE

PRESSURE ALTITUDE — 10,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED



DATA BASIS: FLIGHT TEST

D145-240-10

Figure 7-38. 100% Rotor RPM, 10° and 20°C, 10,000 Feet

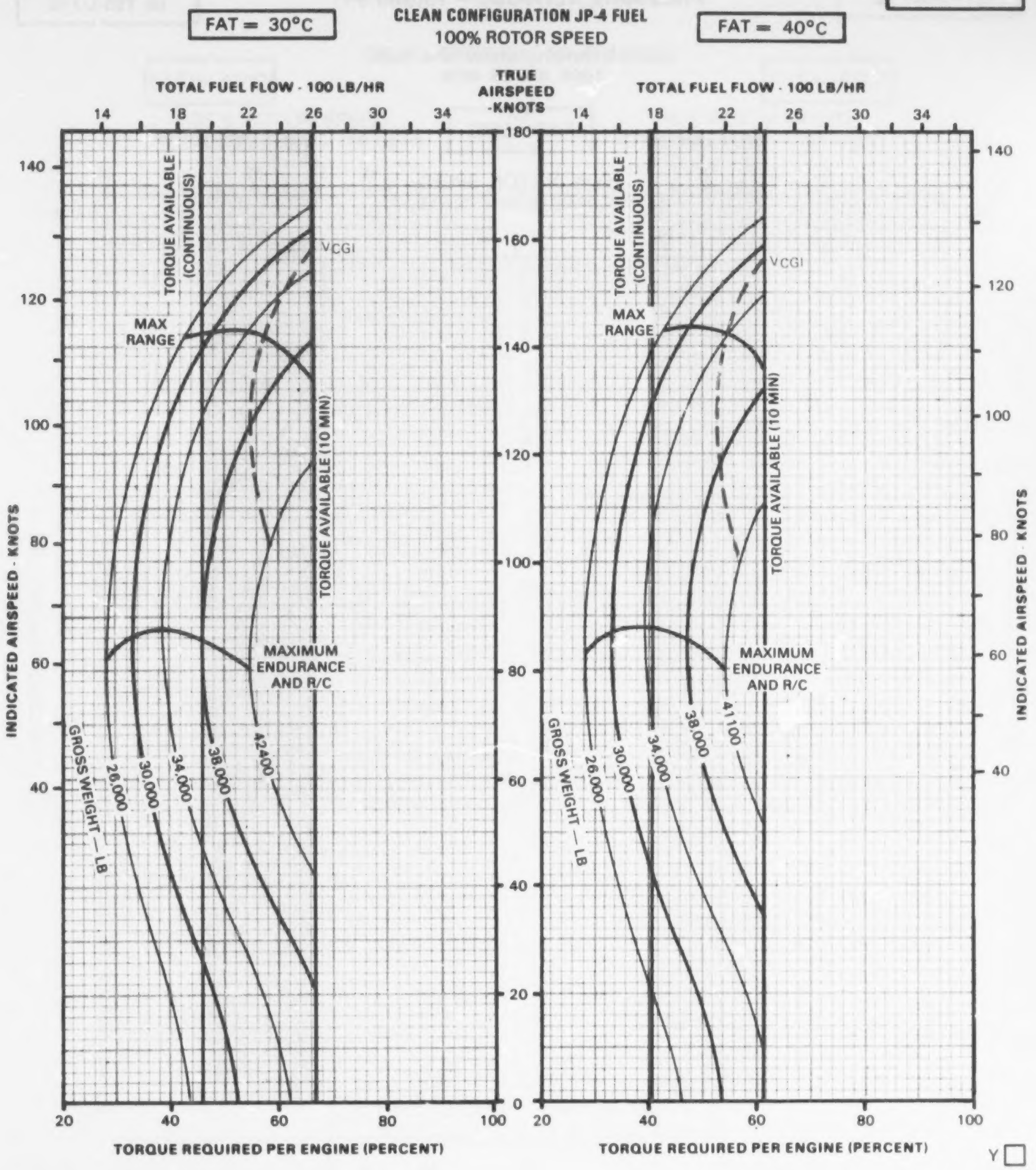
■ R
☐

CRUISE

PRESSURE ALTITUDE — 10,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

D145-241-10

Figure 7-39. 100% Rotor RPM, 30° and 40°C, 10,000 Feet

Y ☐

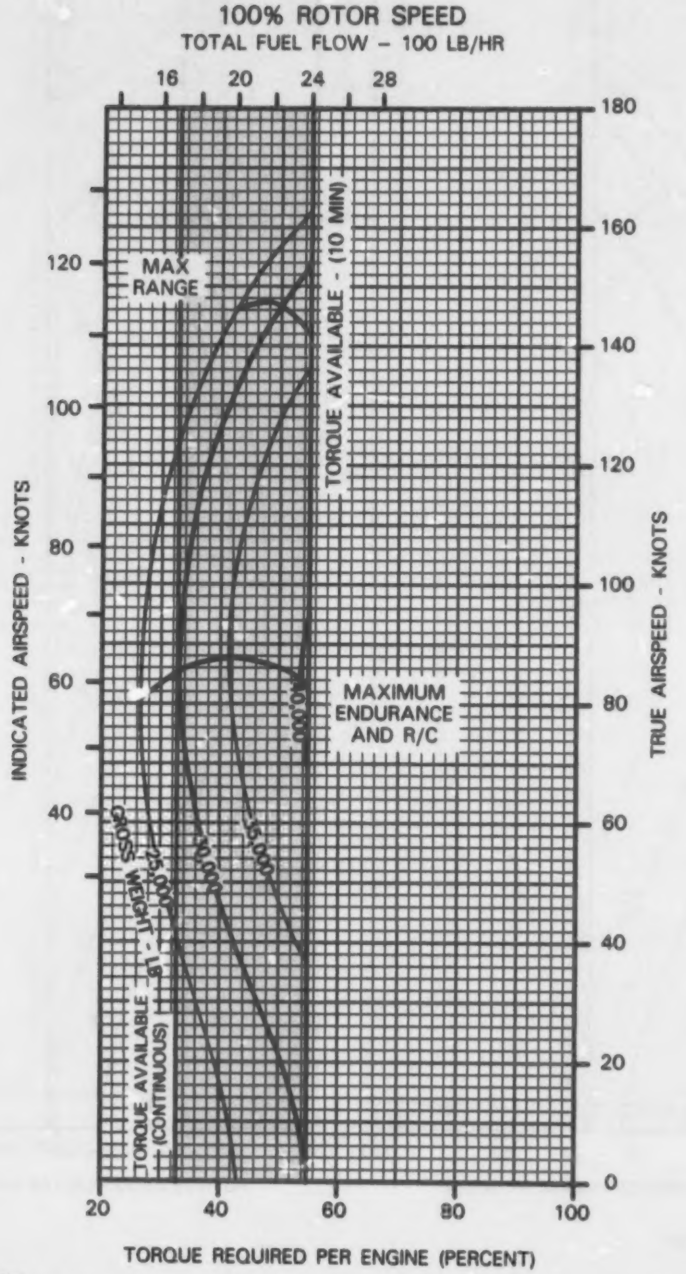
CRUISE
CH-47D
(2) T55-L-712

CRUISE

PRESSURE ALTITUDE - 10,000 FT

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR RPM

FAT=50°C



Y ☐

DATA BASIS: FLIGHT TEST

A9409

Figure 7-39.1. 100% Rotor RPM, 50°C, 10,000 Feet

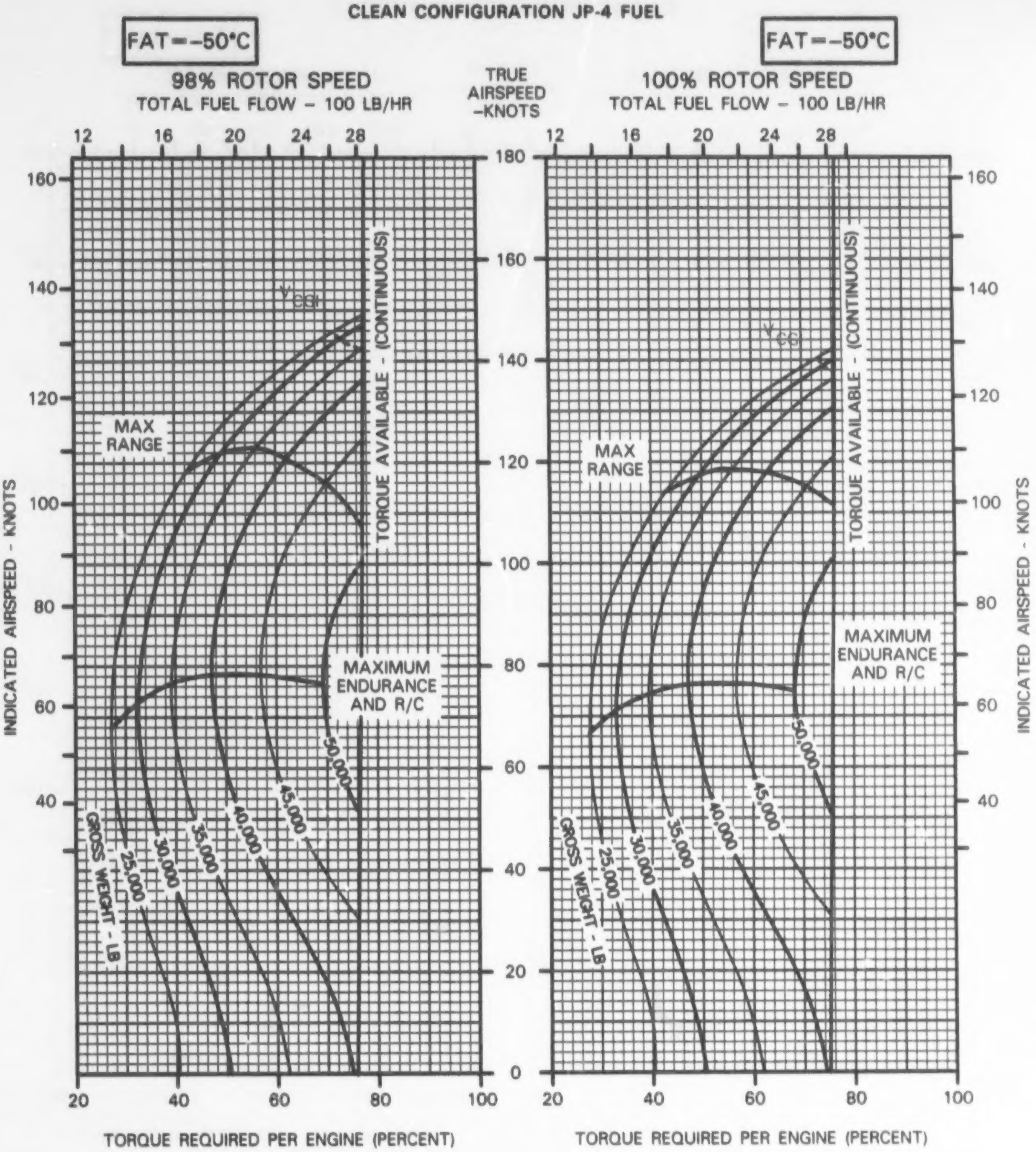
R

CRUISE

PRESSURE ALTITUDE - 12,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

Figure 7-40. 98 and 100% Rotor RPM, -50°C, 12,000 Feet

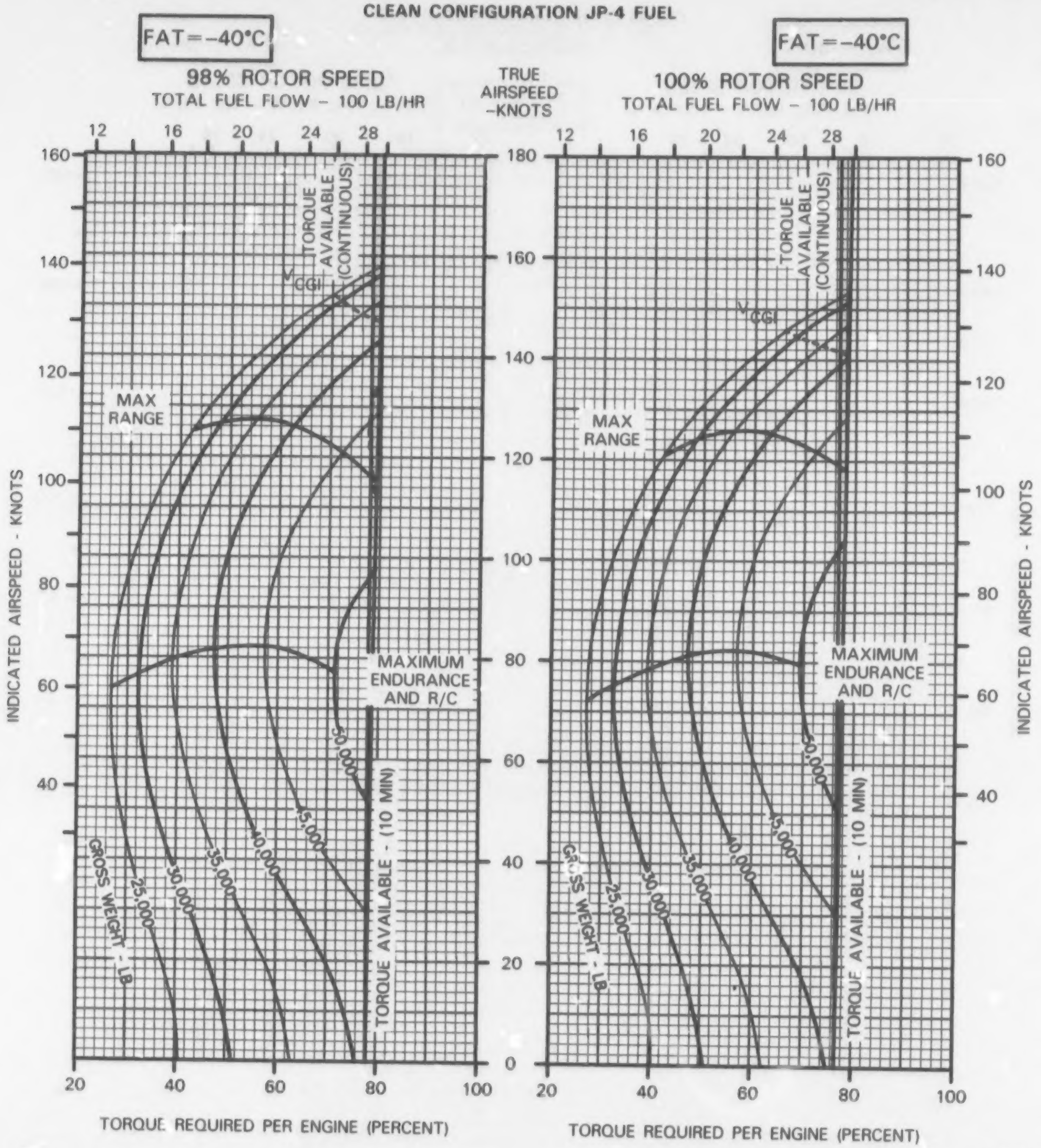
☐
■ R

CRUISE

PRESSURE ALTITUDE - 12,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

Y ☐
R ■
A9410

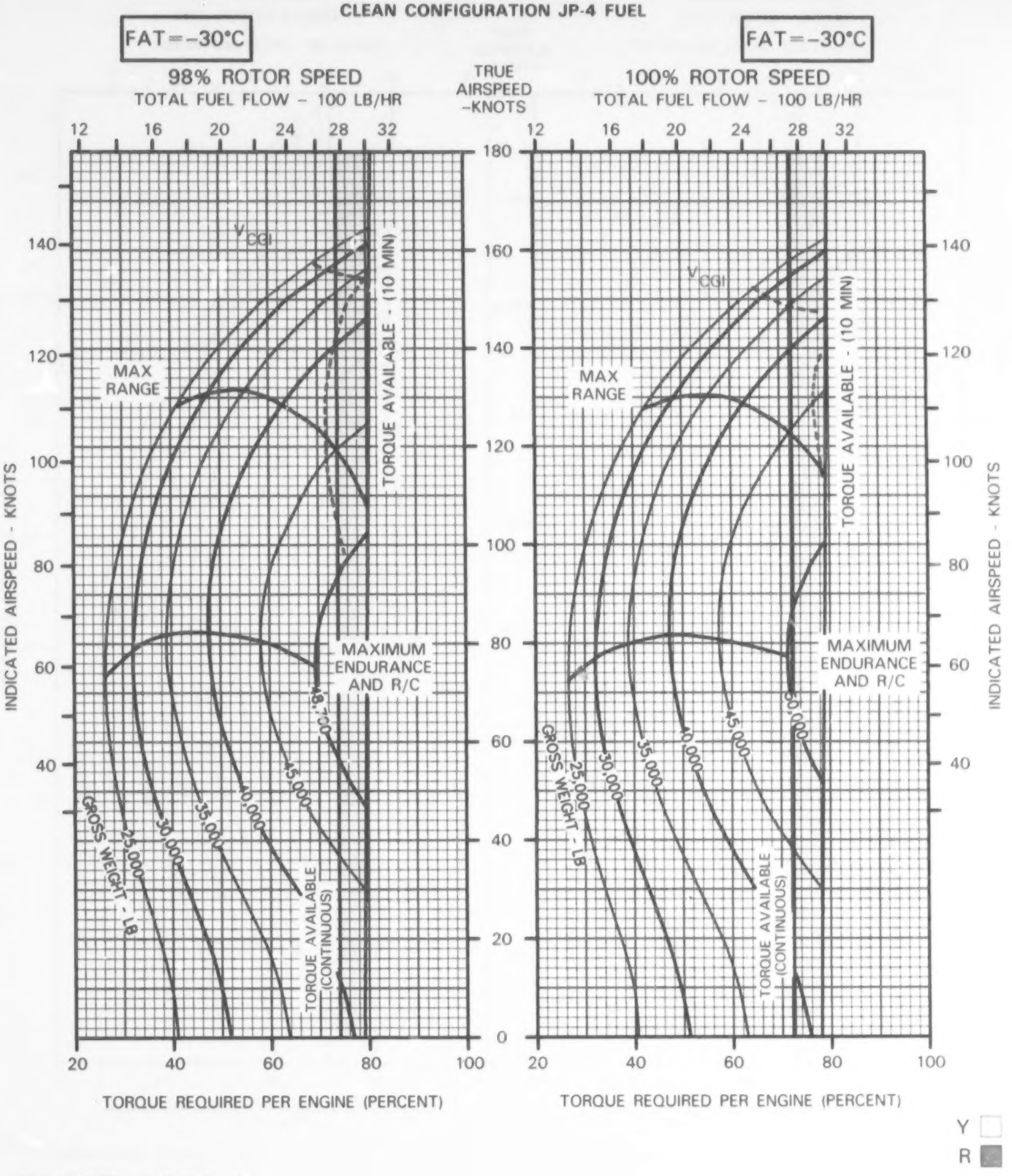
Figure 7-40.1. 98 and 100% Rotor RPM, -40°C, 12,000 Feet

☐
■ R

CRUISE
PRESSURE ALTITUDE - 12,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



A9411

DATA BASIS: FLIGHT TEST

Figure 7-40.2. 98 and 100% Rotor RPM, -30°C, 12,000 Feet

■ R

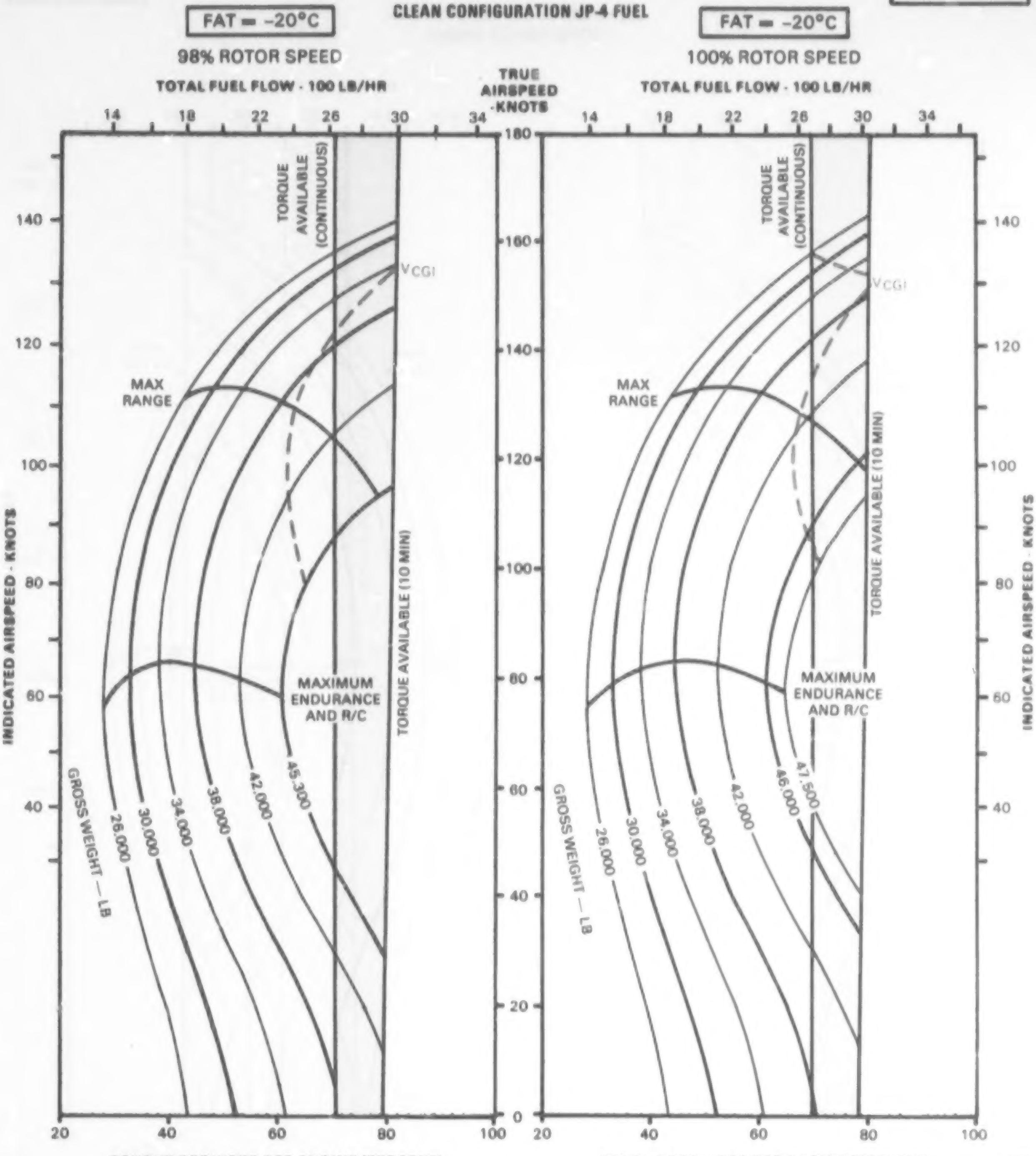
☐

CRUISE

PRESSURE ALTITUDE — 12,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



Y ☐

R ▨

DATA BASIS: FLIGHT TEST

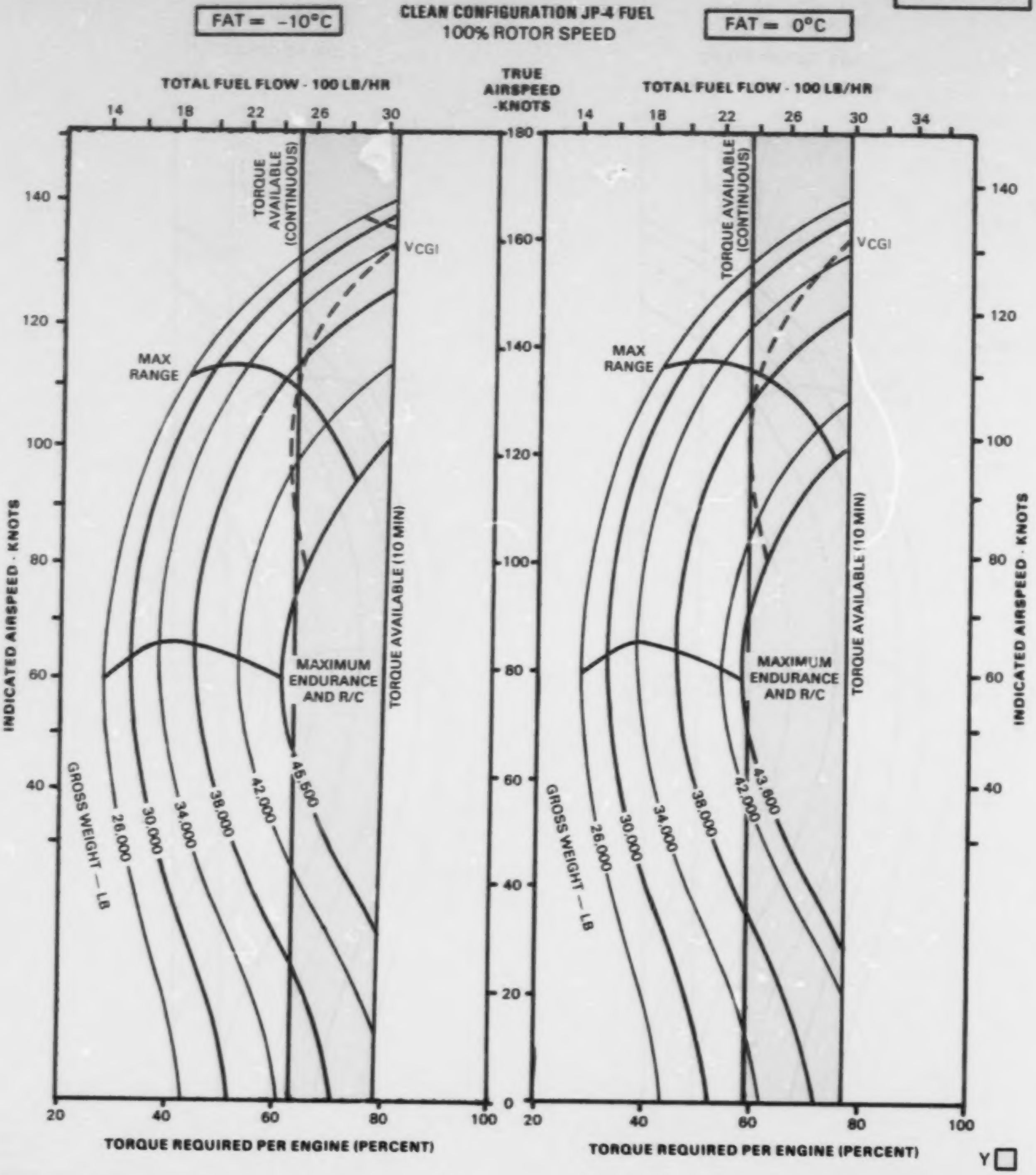
D145-243-10

Figure 7-41. 98 and 100% Rotor RPM, -20°C, 12,000 Feet

■ R
☐

CRUISE
PRESSURE ALTITUDE — 12,000 FT

CRUISE
CH-47D
(2) T55-L-712



DATA BASIS: FLIGHT TEST

D146-244-10

Figure 7-42. 100% Rotor RPM, -10° and 0°C, 12,000 Feet

best copy available

■ R
☐

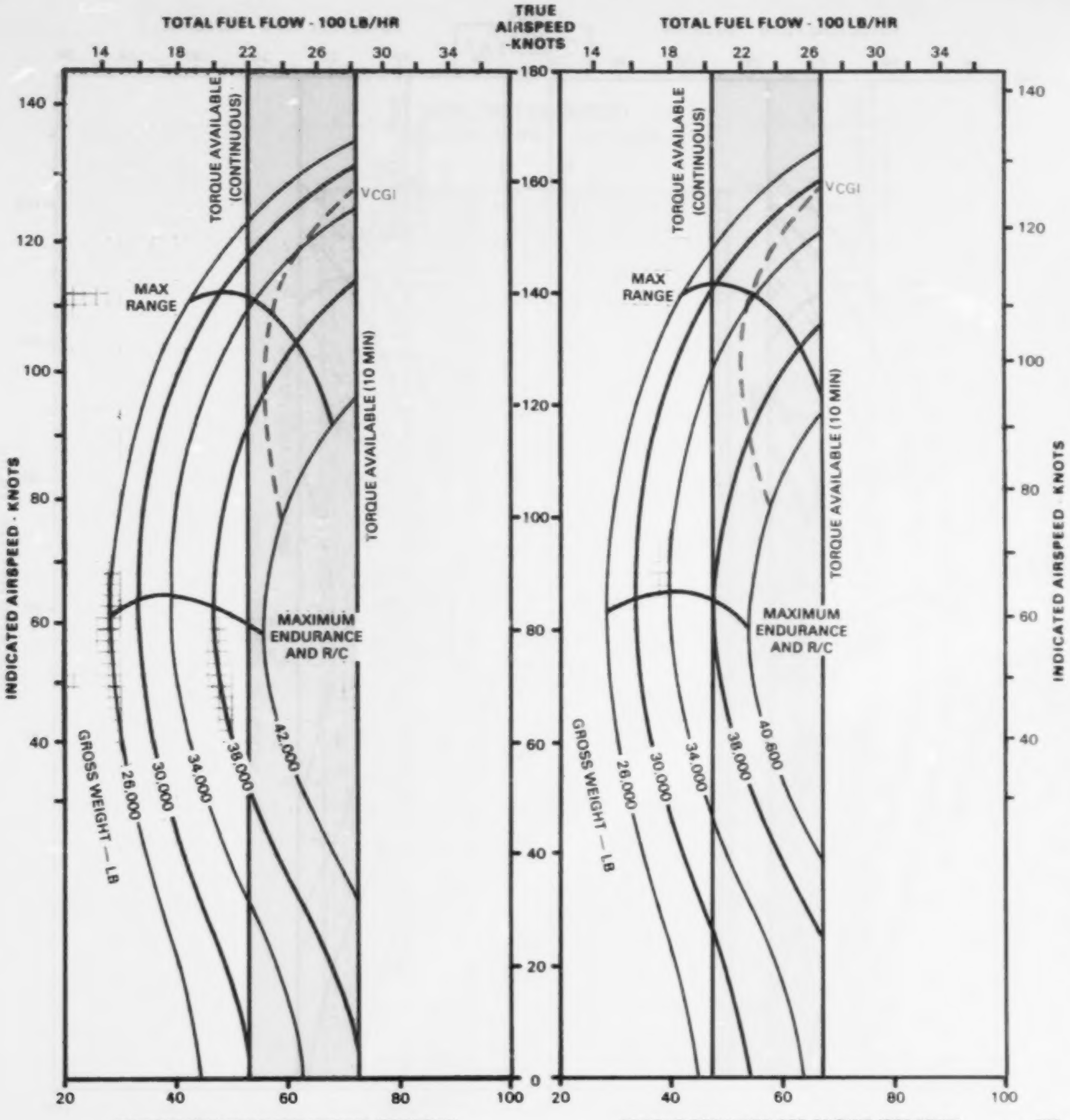
CRUISE
PRESSURE ALTITUDE — 12,000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = 10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 20°C



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

D145-245-10

Figure 7-43. 100% Rotor RPM, 10° and 20°C, 12,000 Feet

■ R
▨ Y

CRUISE

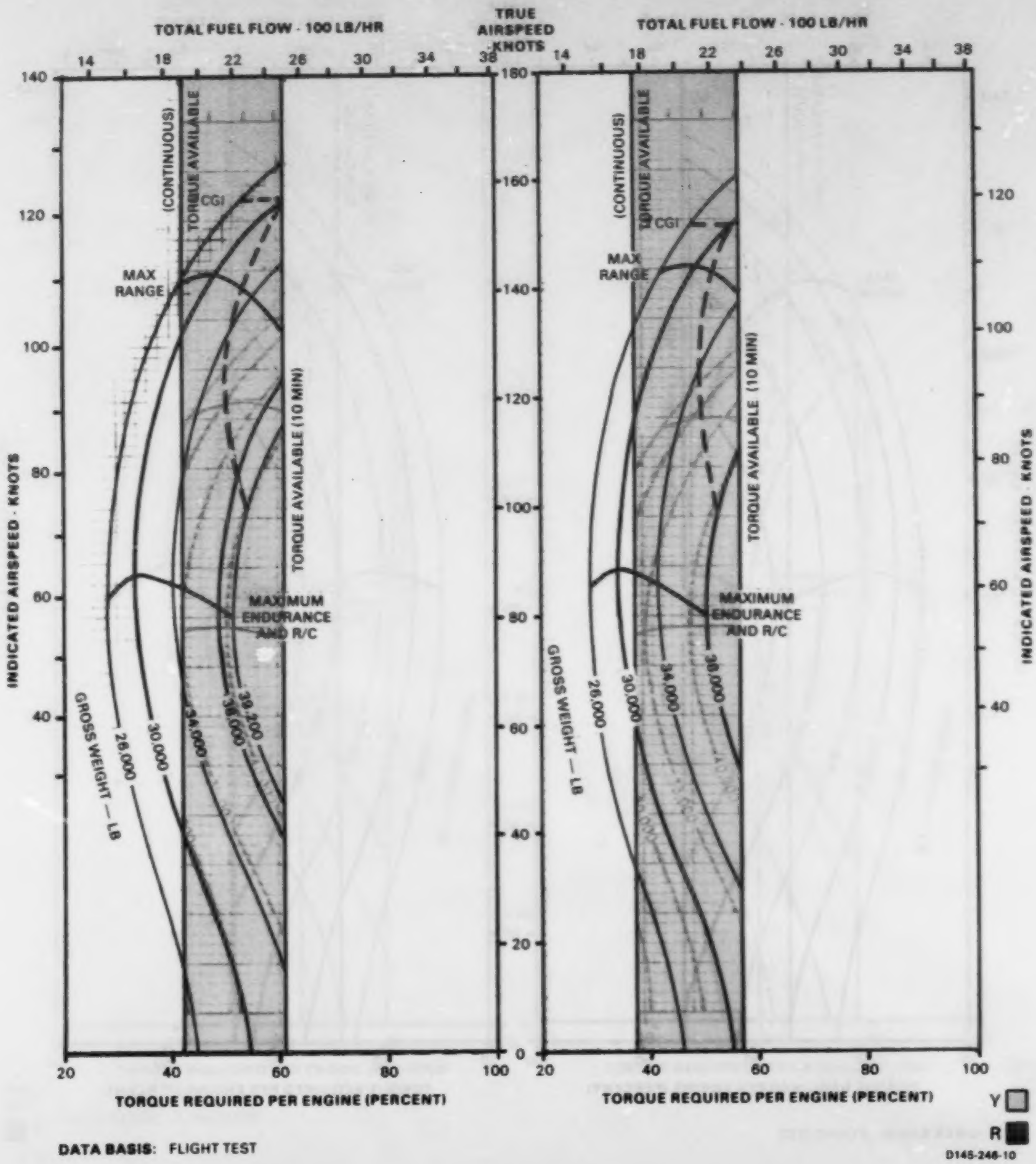
PRESSURE ALTITUDE — 12,000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = 30°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 40°C



DATA BASIS: FLIGHT TEST

D145-246-10

Table 7-44. 100% Rotor RPM, 30° and 40°C, 12,000 Feet

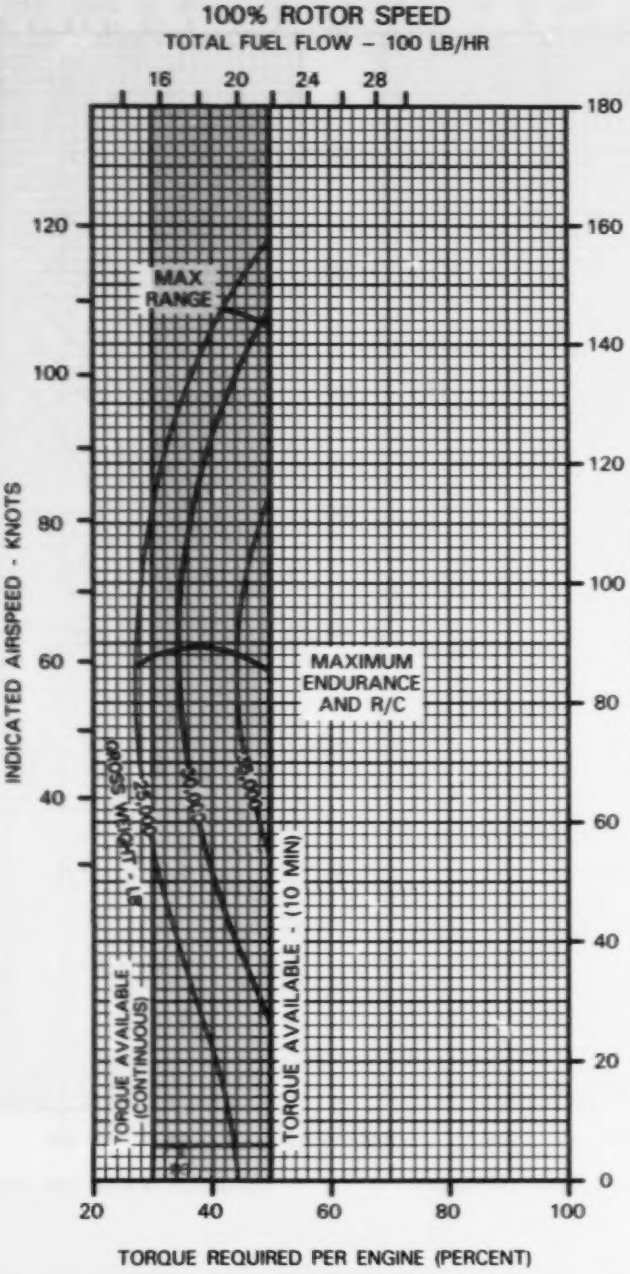
CRUISE

PRESSURE ALTITUDE - 12,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL

FAT=50°C



DATA BASIS: FLIGHT TEST

A9412

Figure 7-44.1. 100% Rotor RPM, 50°C, 12,000 Feet

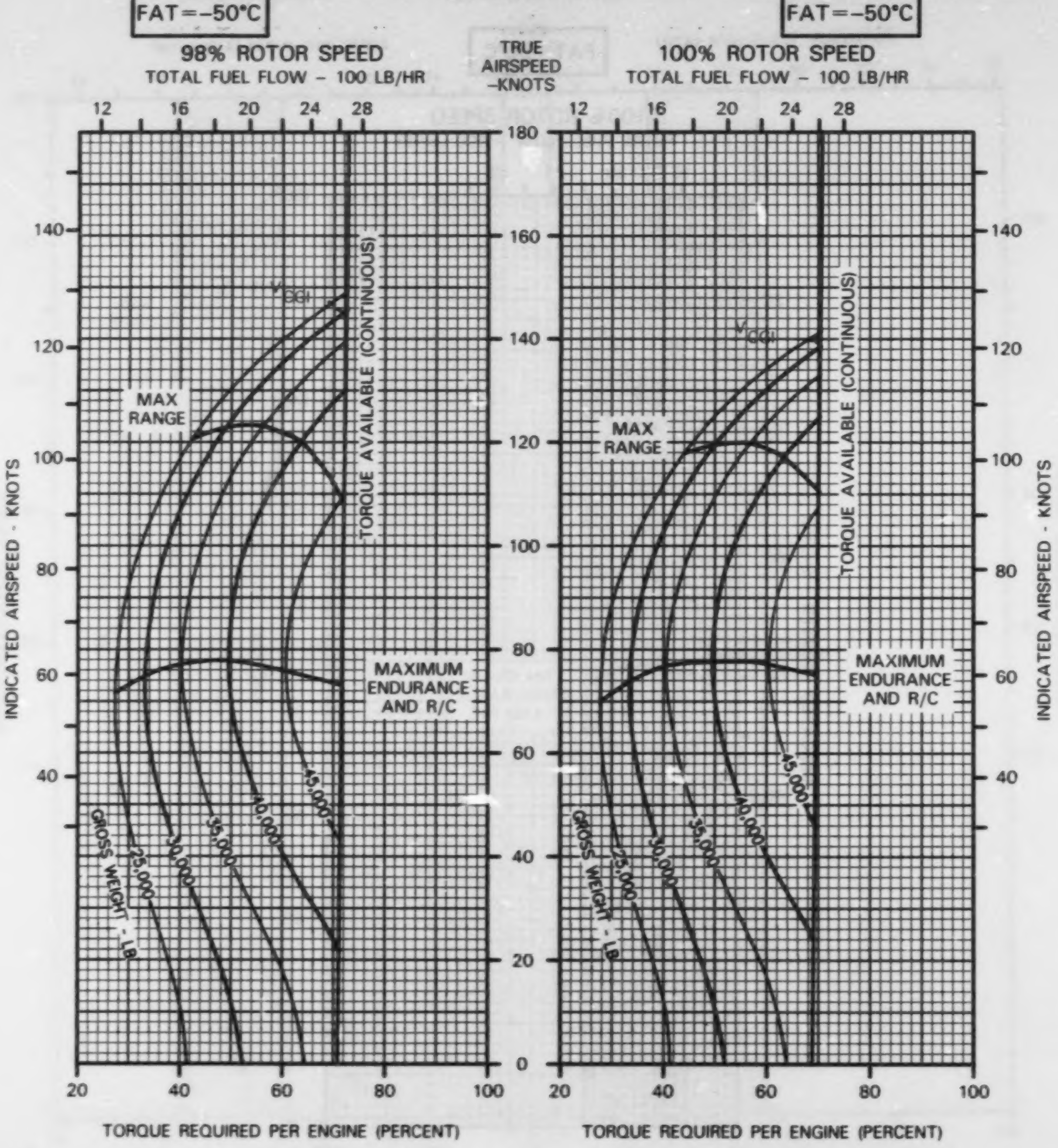
R

CRUISE

PRESSURE ALTITUDE - 14,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



R

A9413

DATA BASIS: FLIGHT TEST

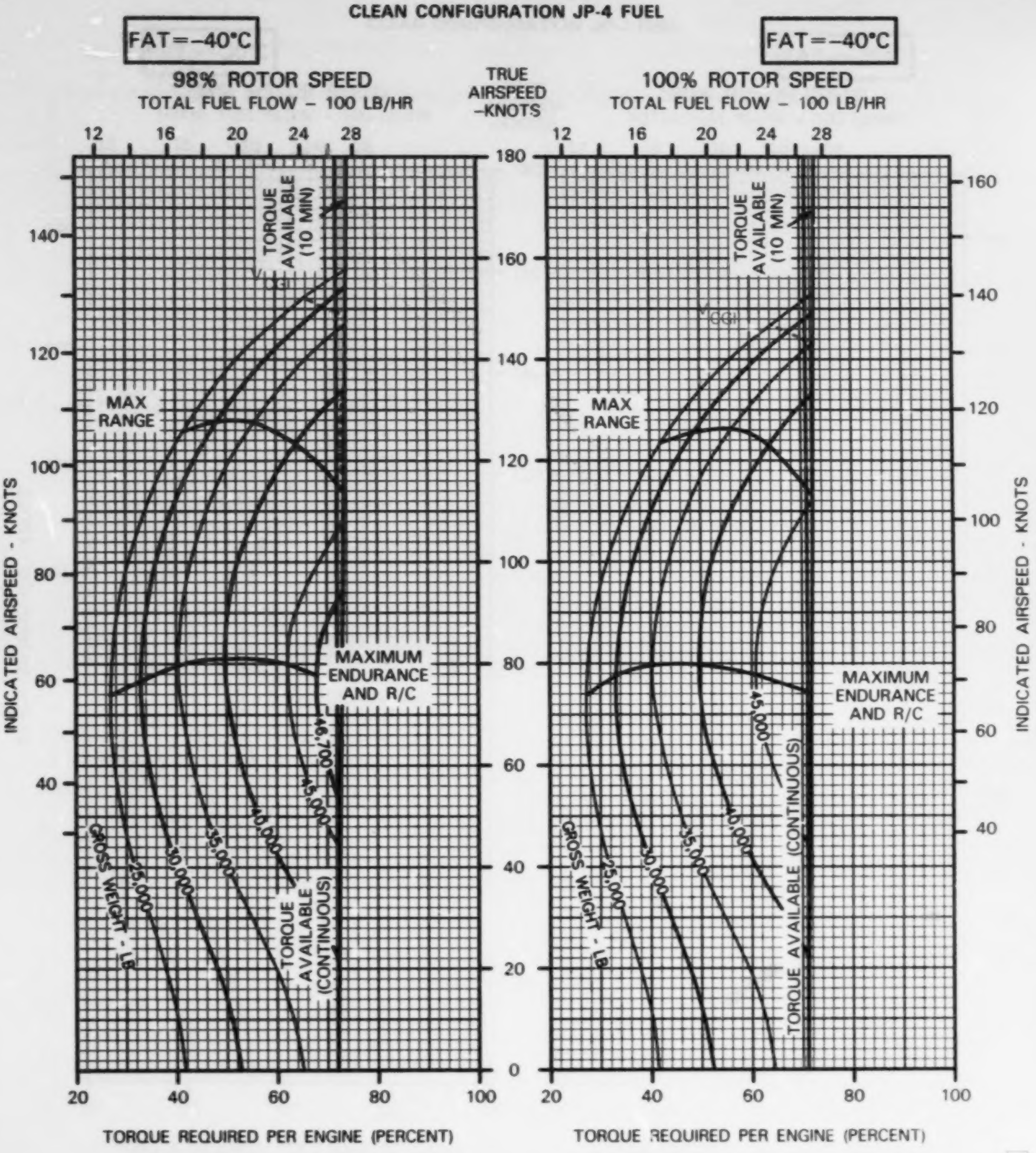
Figure 7-45. 98 and 100% Rotor RPM, -50°C, 14,000 Feet

CRUISE

PRESSURE ALTITUDE - 14,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

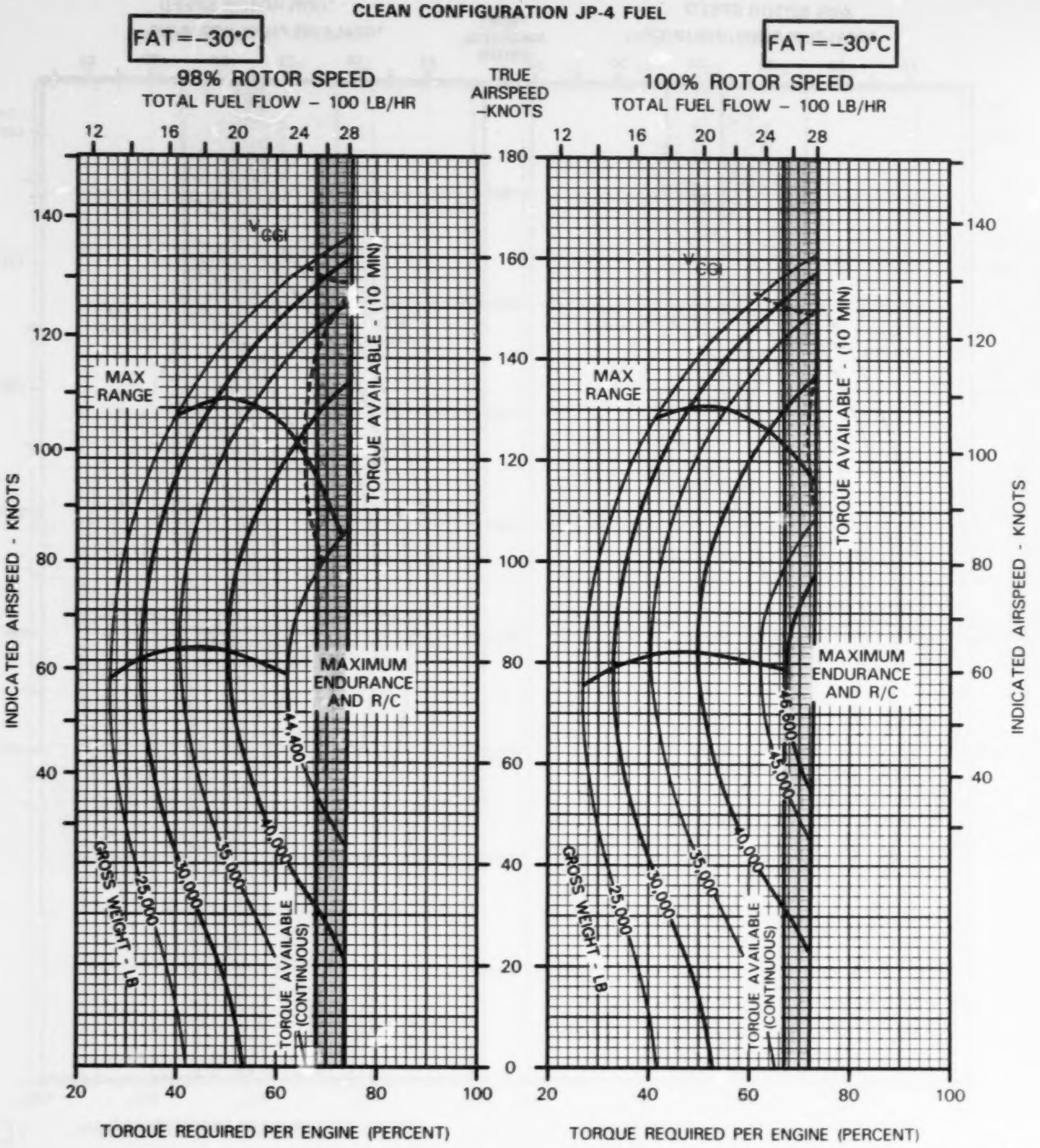
Figure 7-45.1. 98 and 100% Rotor RPM, -40°C, 14,000 Feet

CRUISE

PRESSURE ALTITUDE - 14,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

A9415

Figure 7-45.2. 98 and 100% Rotor RPM, -30°C, 14,000 Feet

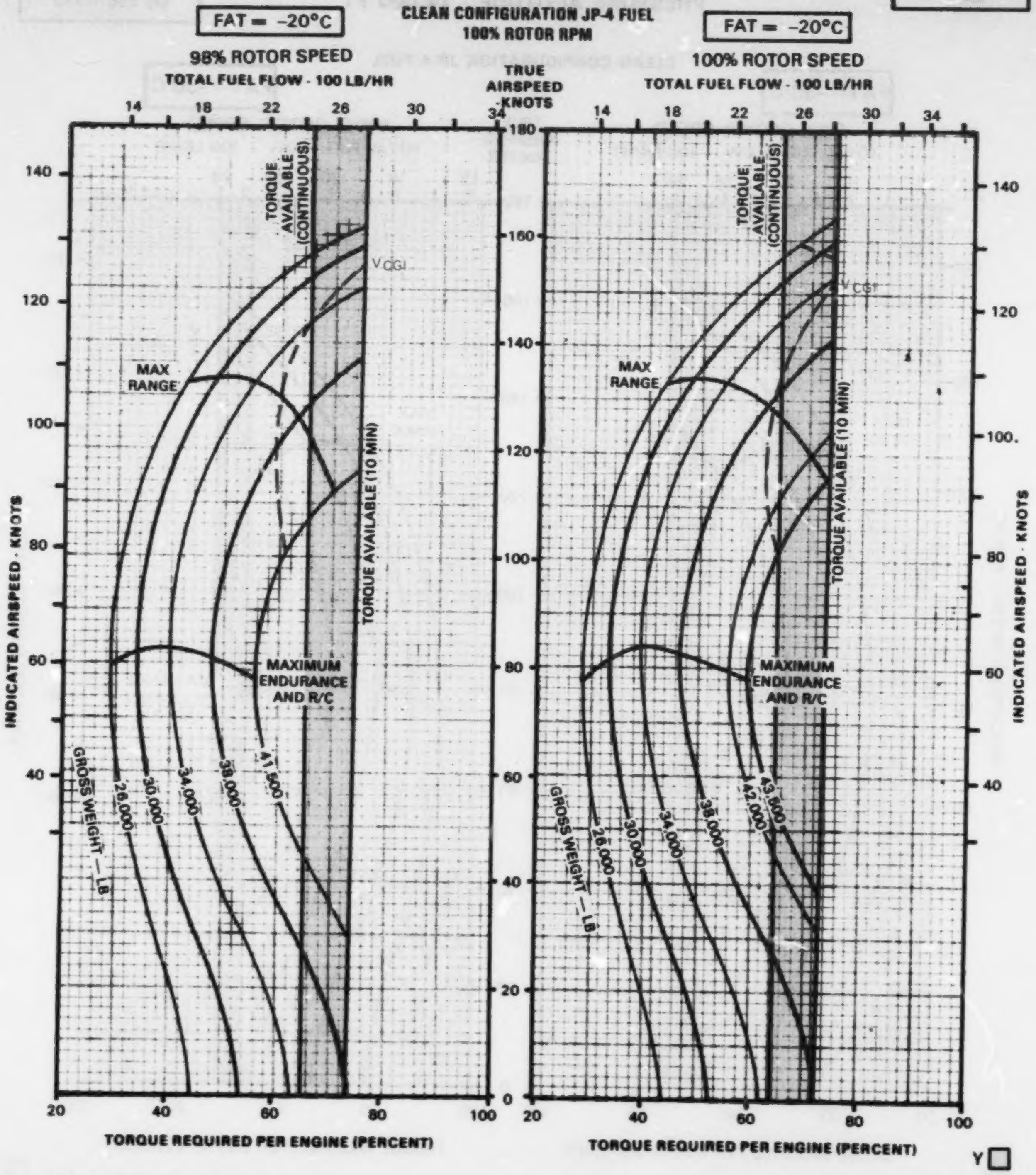
■ R

▨ Y

CRUISE

PRESSURE ALTITUDE — 14,000 FT

CRUISE
CH-47D
(2) T55-L-712



DATA BASIS: FLIGHT TEST

Y ▨

R ■

D145-248-10

Figure 7-46. 98 and 100% Rotor RPM, -20°C, 14,000 Feet

■ R
▨

CRUISE

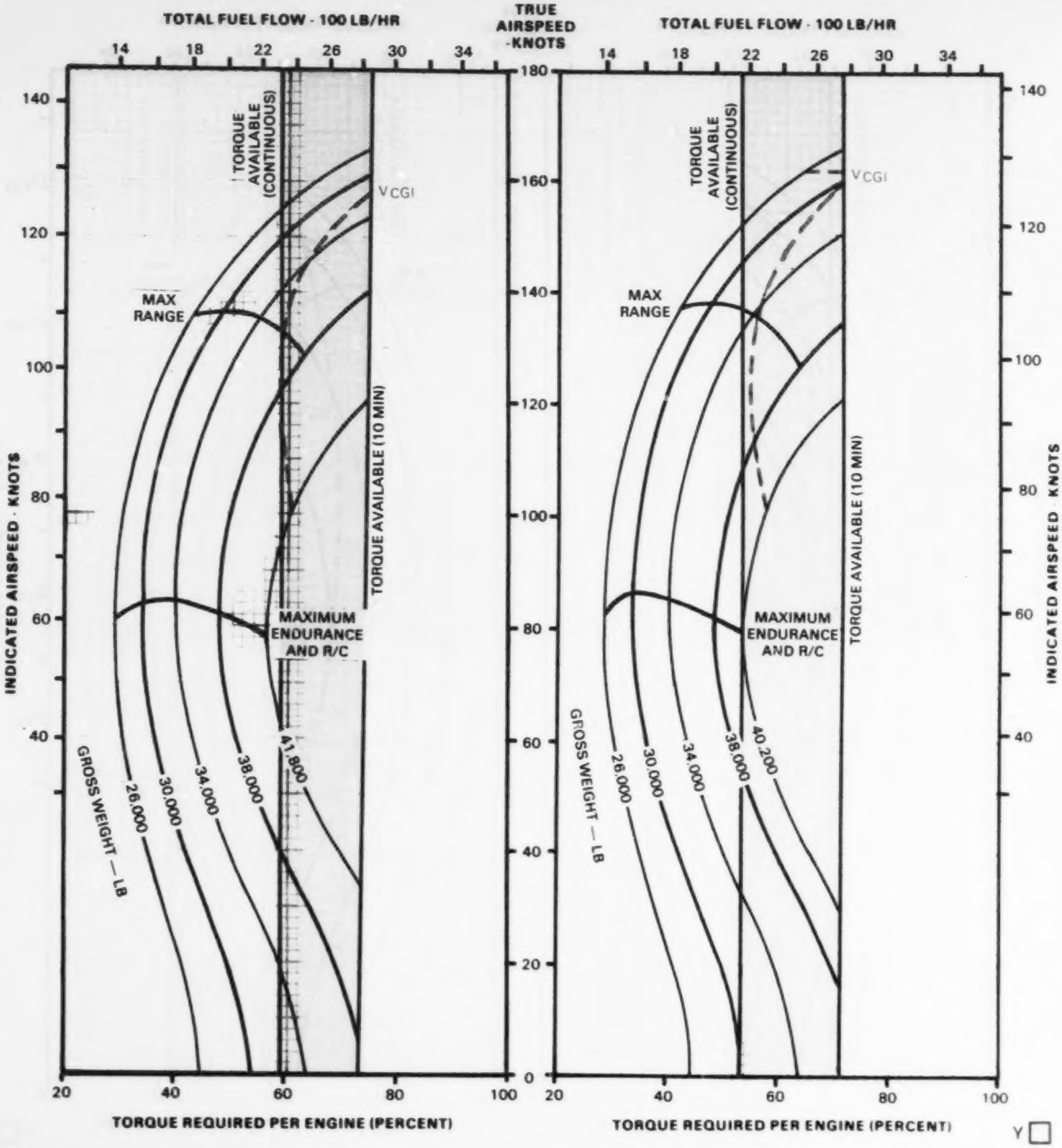
PRESSURE ALTITUDE — 14,000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = -10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 0°C



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

Figure 7-47. 100% Rotor RPM, -10° and 0°C, 14,000 Feet

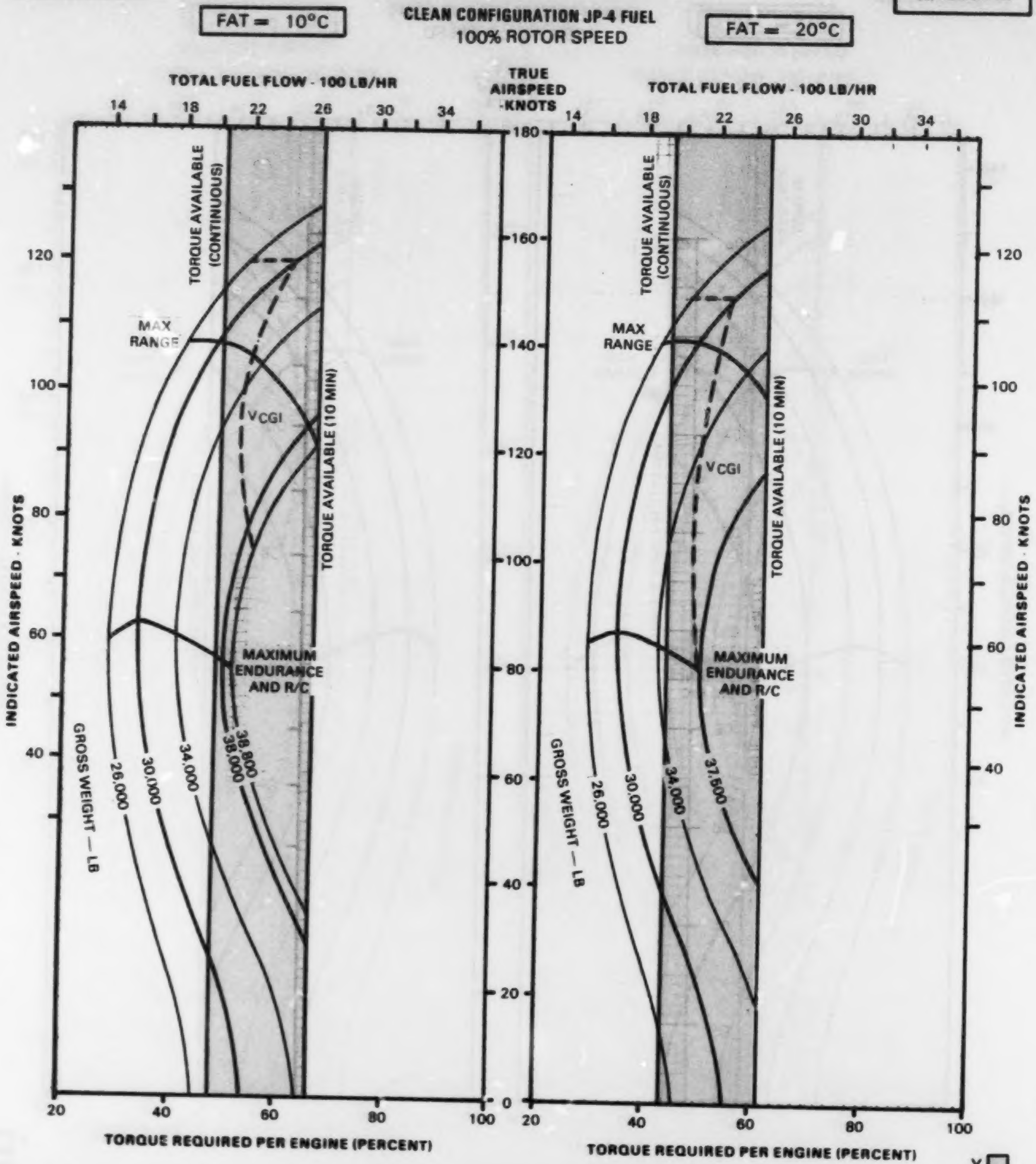
■ R
□ Y

CRUISE

PRESSURE ALTITUDE — 14,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED



DATA BASIS: FLIGHT TEST

Figure 7-48. 100% Rotor RPM, 10° and 20°C, 14,000 Feet

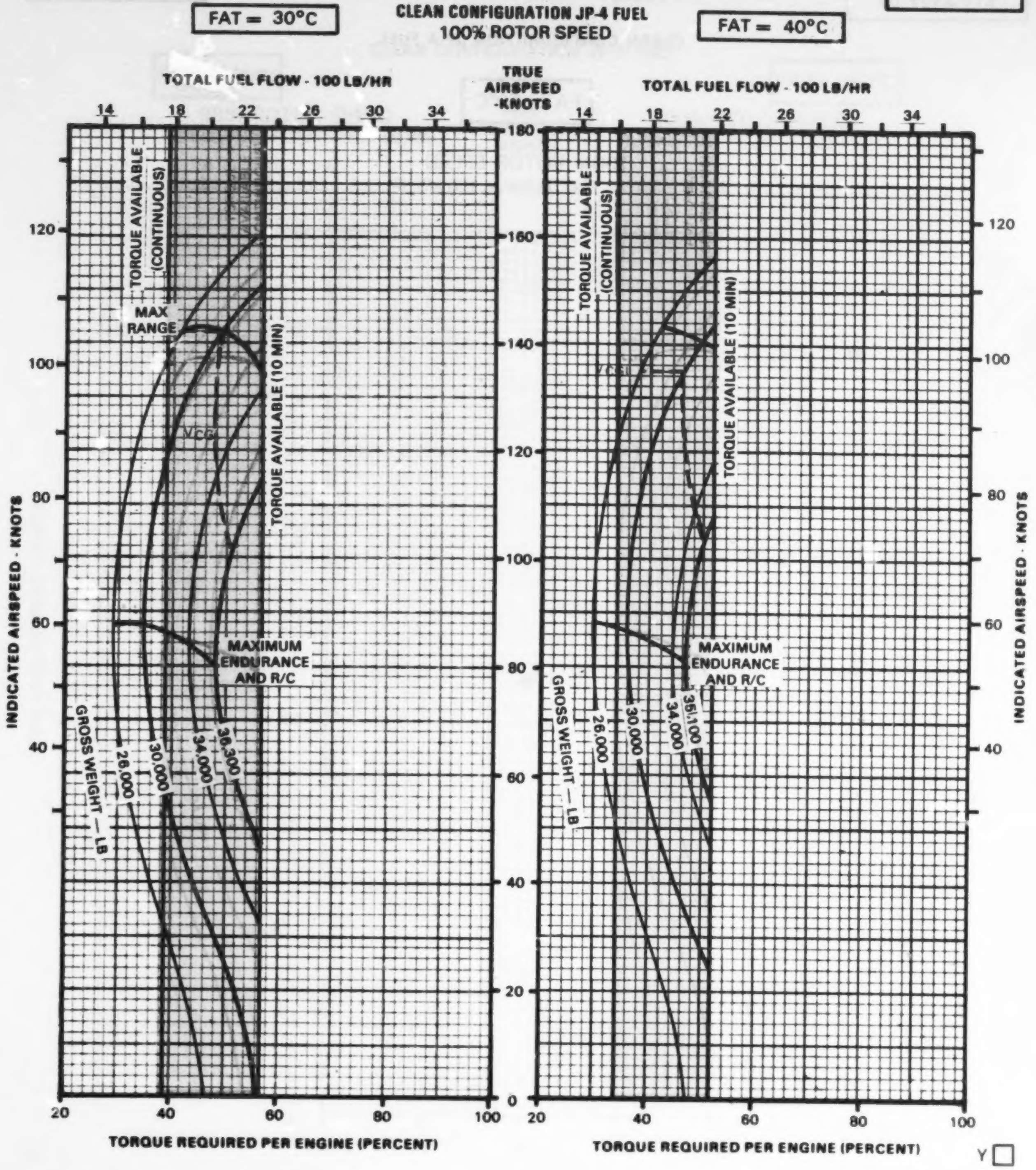
▨ R
☐ Y

CRUISE

PRESSURE ALTITUDE — 14,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED



DATA BASIS: FLIGHT TEST

D145-251-10

Figure 7-49. 100% Rotor RPM, 30° and 40°C, 14,000 Feet

☐

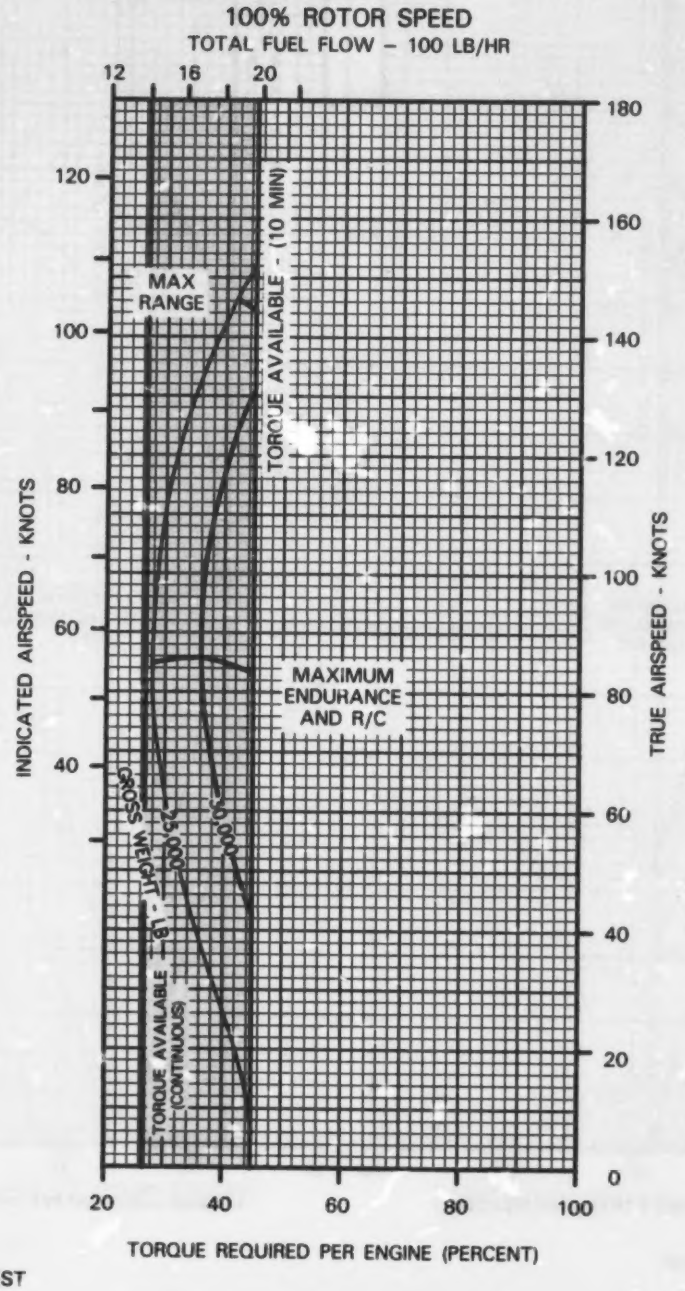
CRUISE

PRESSURE ALTITUDE - 14,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL

FAT=50°C



☐

DATA BASIS: FLIGHT TEST

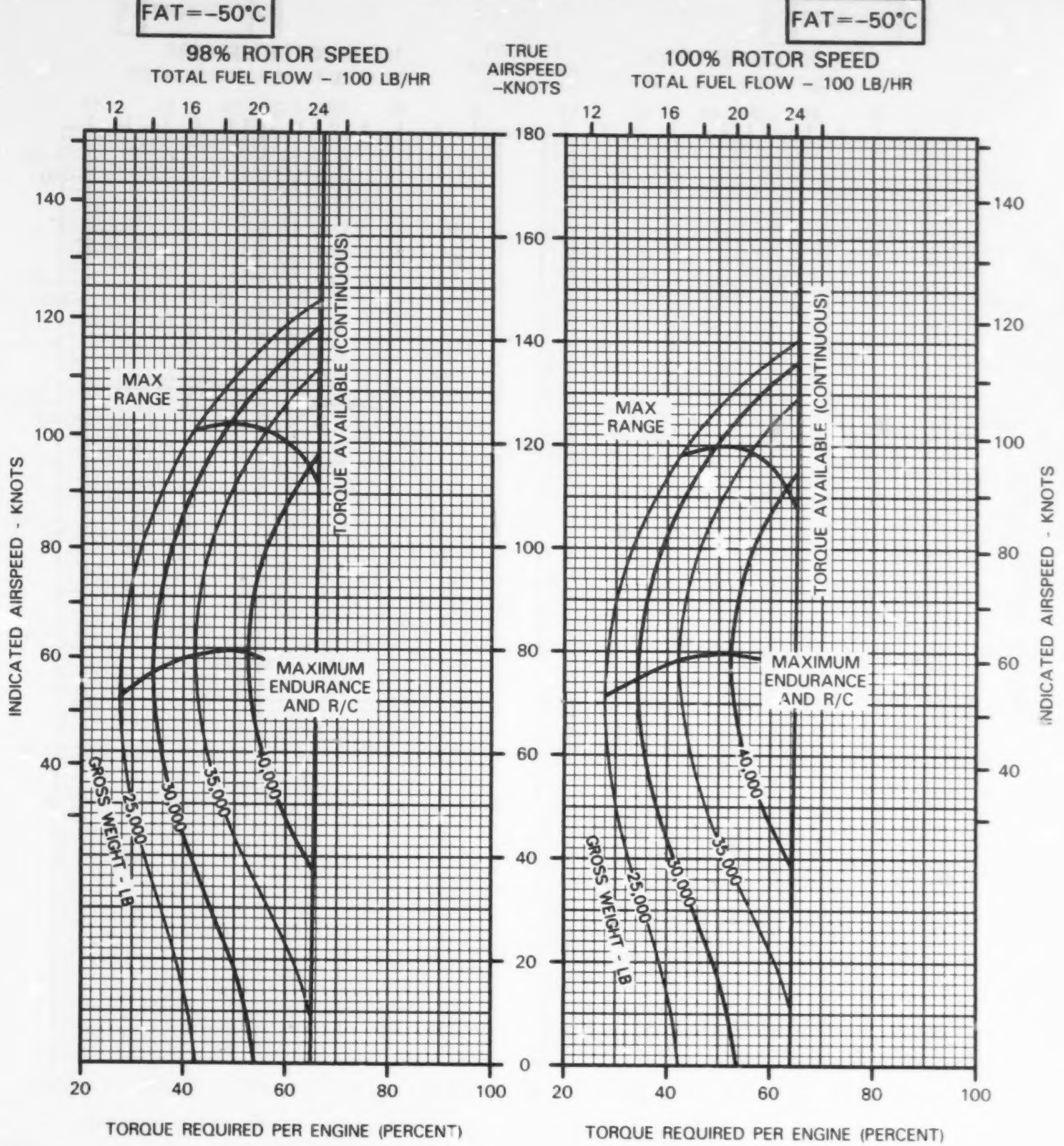
A9416

Figure 7-49.1. 100% Rotor RPM, 50°C, 14,000 Feet

CRUISE

PRESSURE ALTITUDE - 16,000 FT

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

A9417

Figure 7-50. 98 and 100% Rotor RPM, -50°C, 16,000 Feet

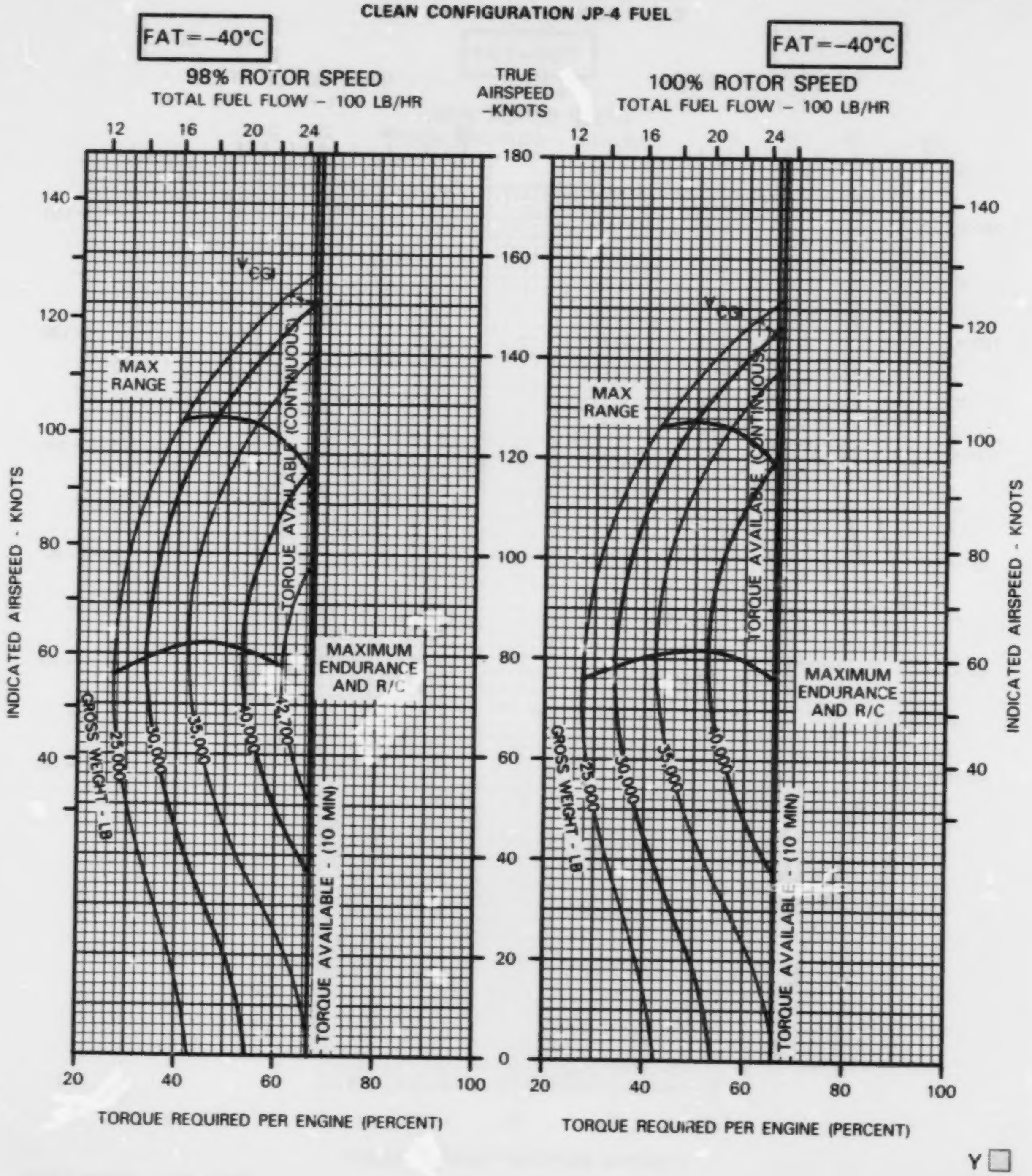
☐
■ R

CRUISE

PRESSURE ALTITUDE - 16,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

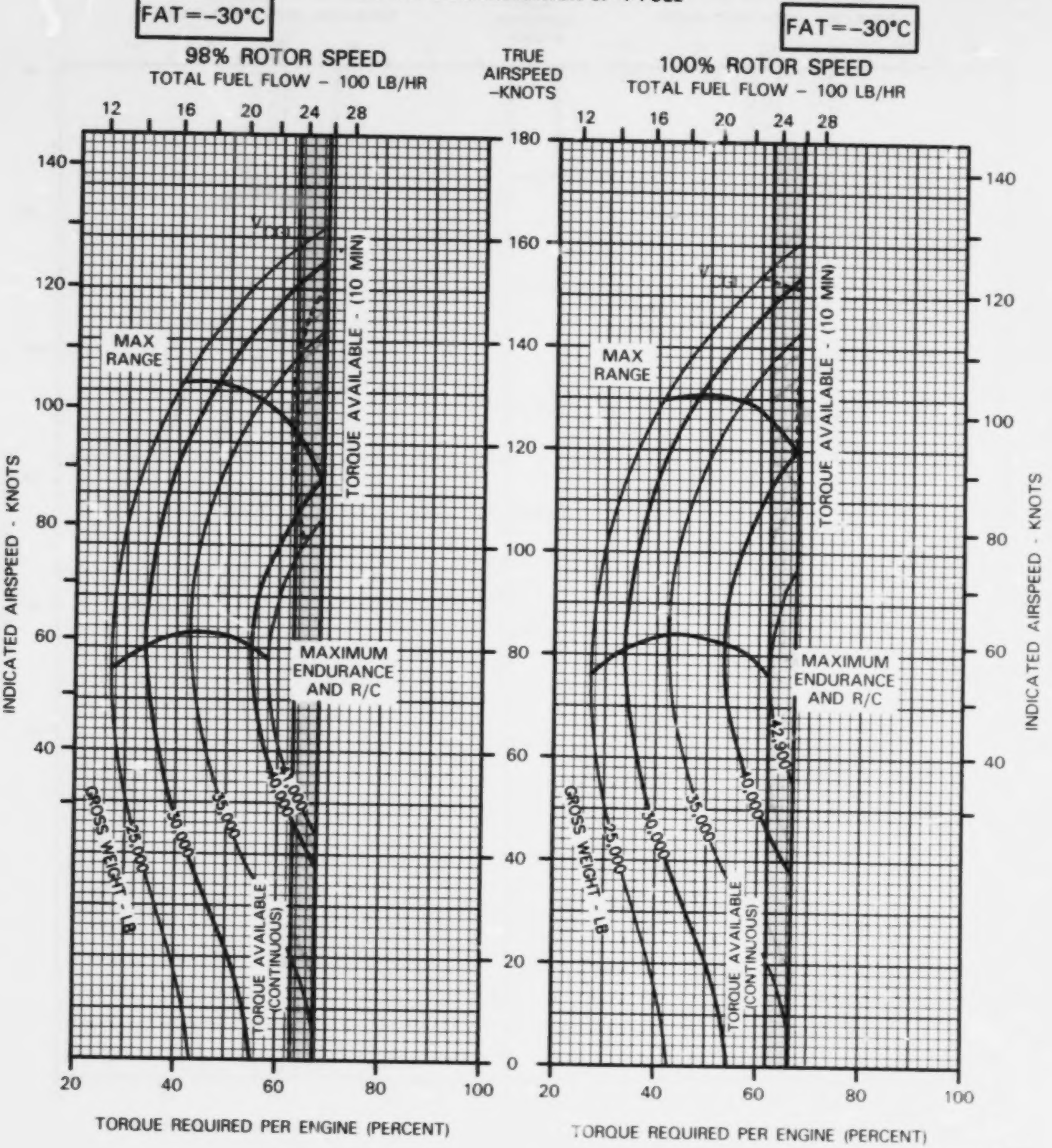
Figure 7-50.1. 98 and 100% Rotor RPM, -40°C, 16,000 Feet

Y ▨
R ■

CRUISE

PRESSURE ALTITUDE - 16,000 FT

CLEAN CONFIGURATION JP-4 FUEL



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

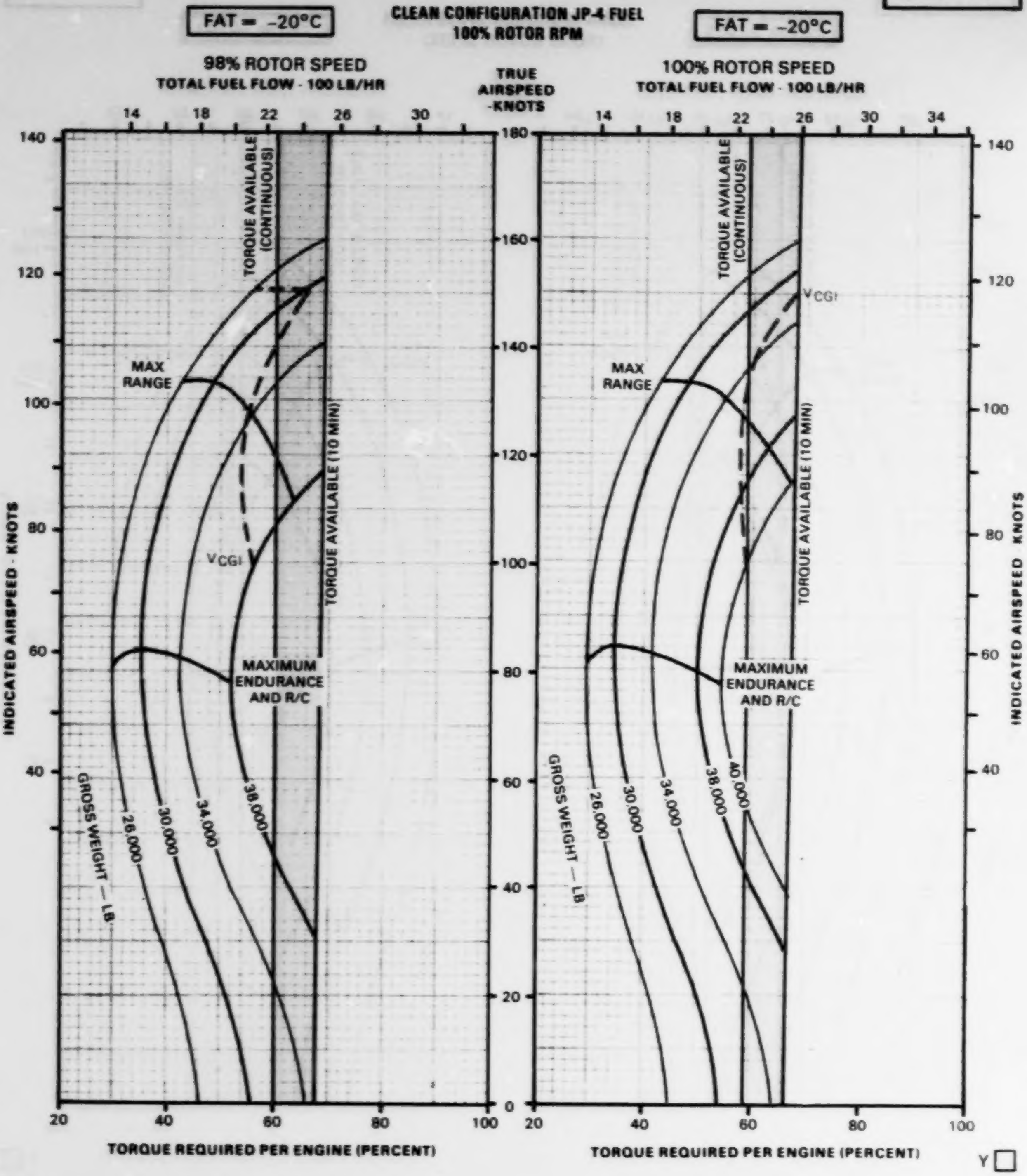
A9419

Figure 7-50.2. 98 and 100% Rotor RPM, -30°C, 16,000 Feet

🟥 R

CRUISE

PRESSURE ALTITUDE — 16,000 FT



Y ☐

R 🟥

DATA BASIS: FLIGHT TEST

D145-253-10

Figure 7-51. 98 and 100% Rotor RPM, -20°C, 16,000 Feet

■ R
☐

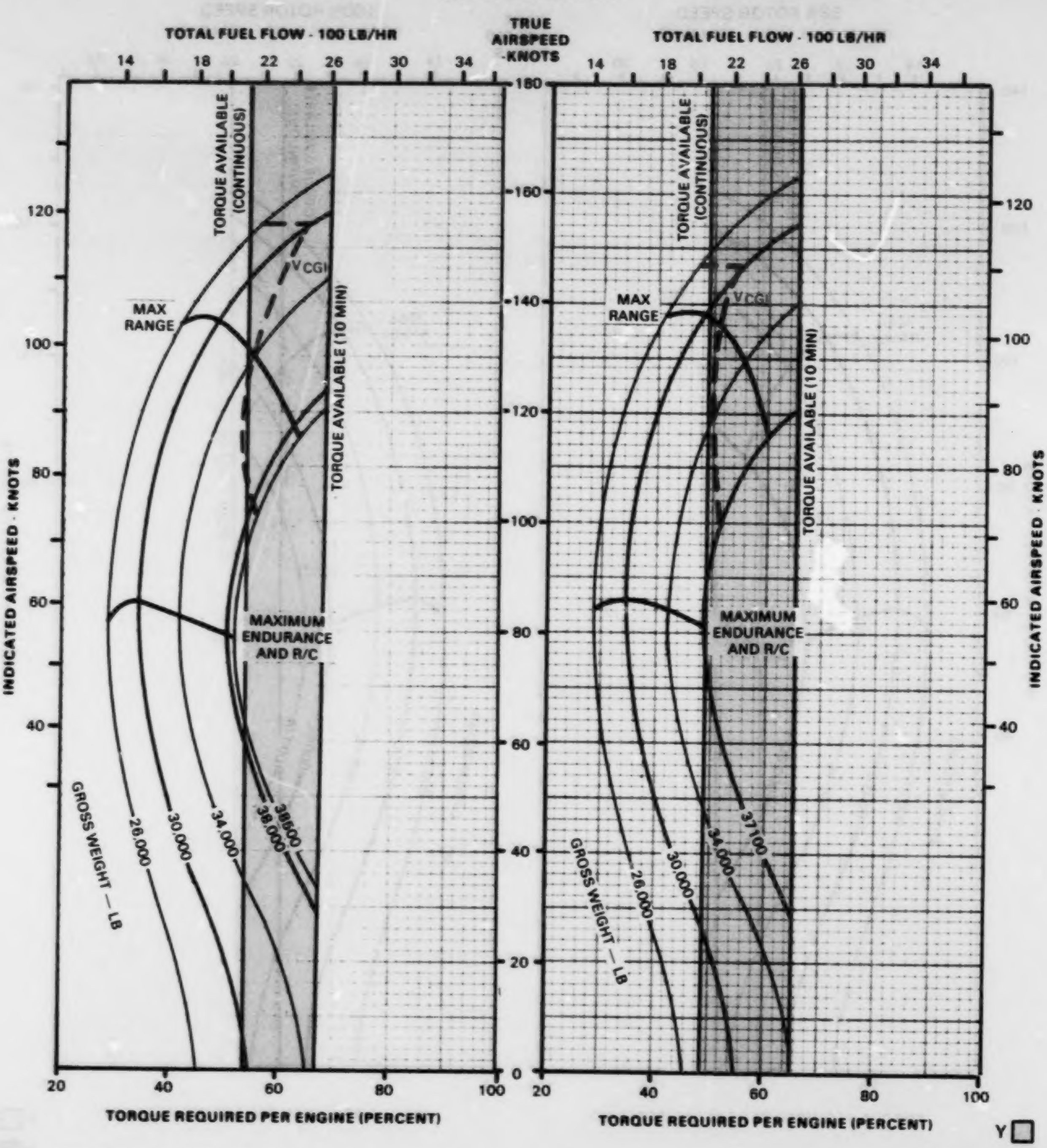
CRUISE
PRESSURE ALTITUDE — 16,000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = -10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 0°C



Y ☐
R ■

DATA BASIS: FLIGHT TEST

D145-254-10

Figure 7-52. 100% Rotor RPM, -10° and 0°C, 16,000 Feet

■ R

▨ Y

CRUISE

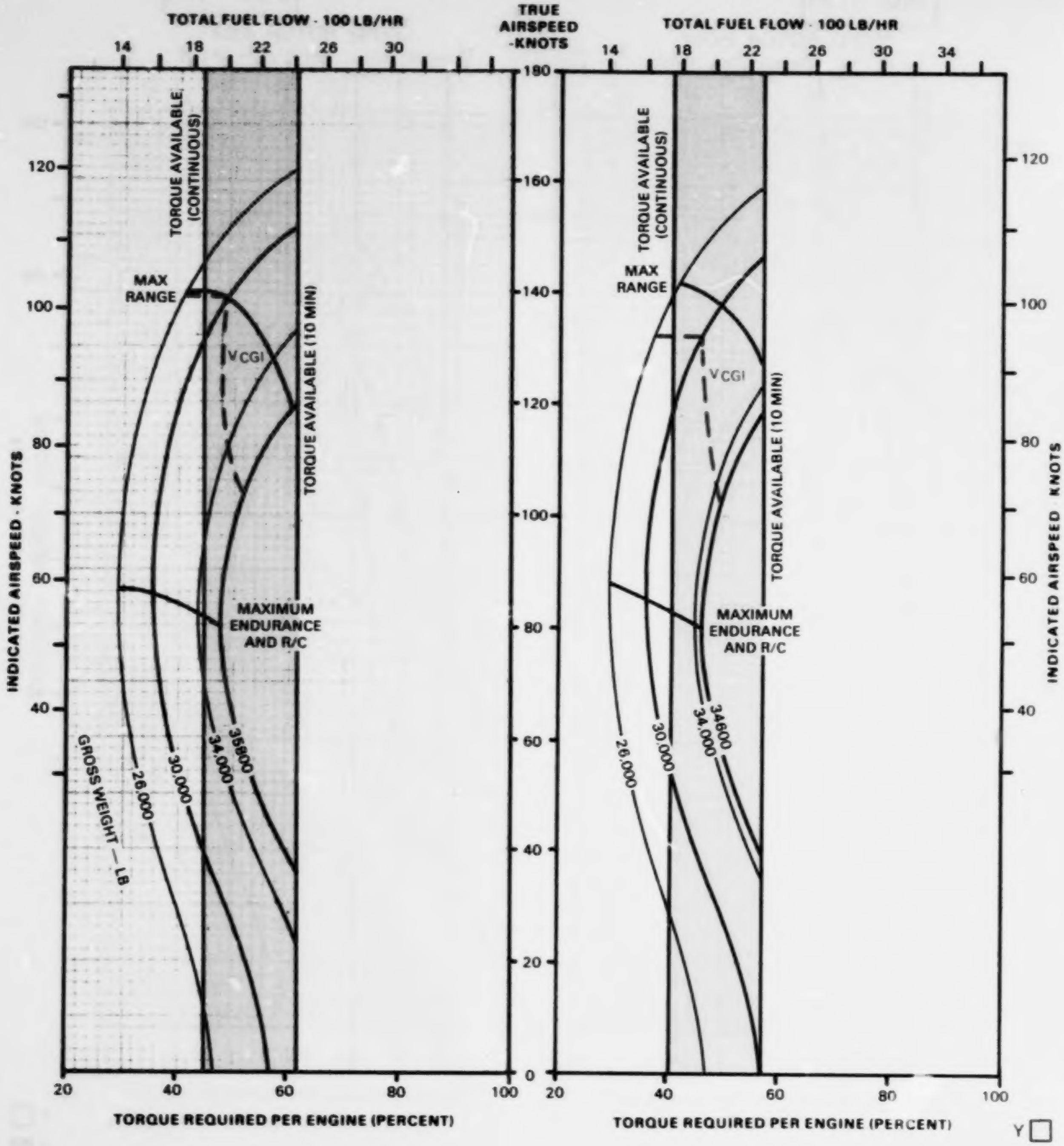
PRESSURE ALTITUDE — 16,000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = 10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 20°C



Y ☐

R ▨

DATA BASIS: FLIGHT TEST

D145-255-10

Figure 7-53. 100% Rotor RPM, 10° and 20°C, 16,000 Feet

■ R

☐

CRUISE

PRESSURE ALTITUDE — 16,000 FT

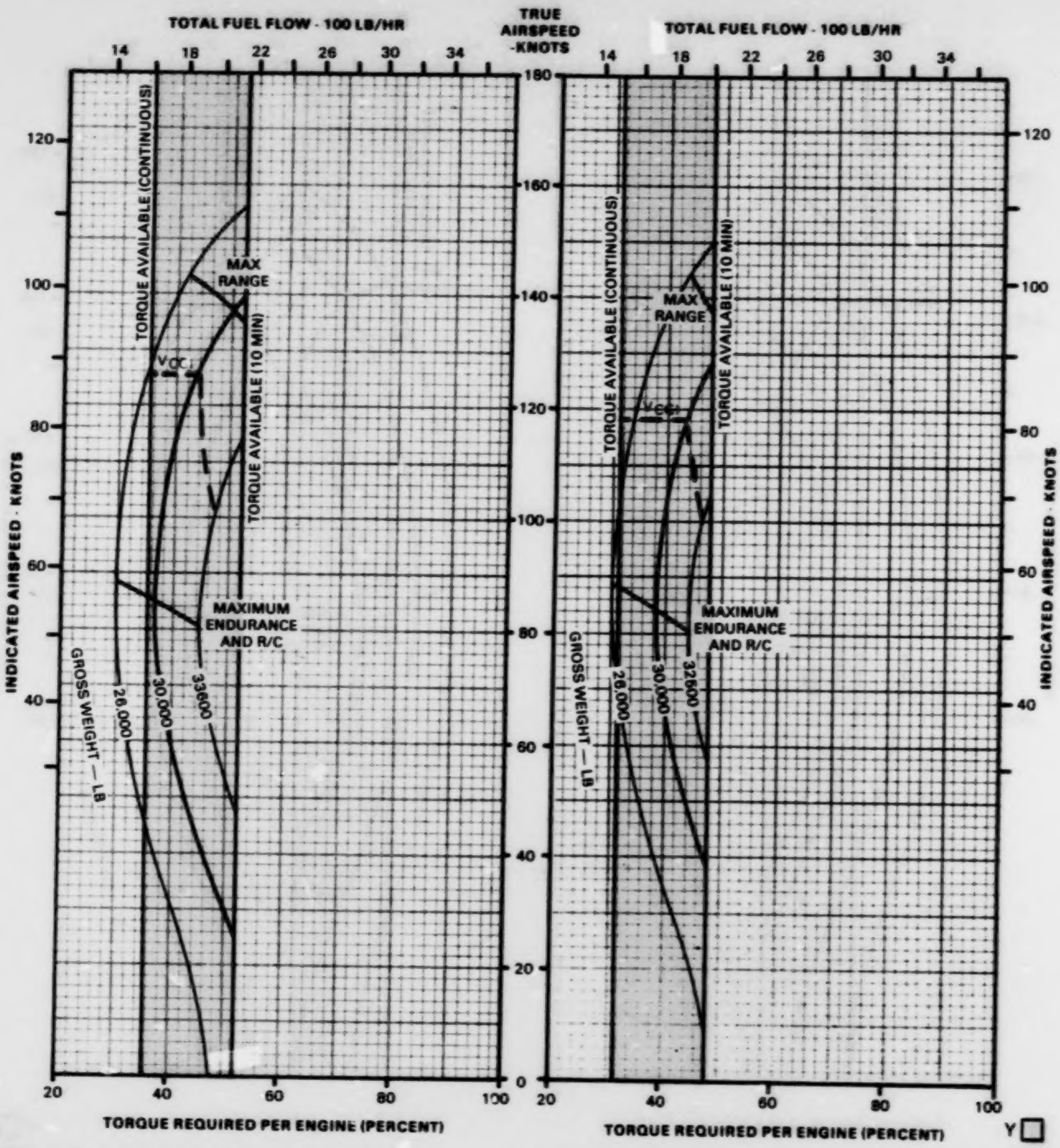
CRUISE
CH-47D
(2) T55-L-712

FAT = 30°C

CLEAN CONFIGURATION JP-4 FUEL

100% ROTOR SPEED

FAT = 40°C



Y ☐

R ■

DATA BASIS: DERIVED FROM FLIGHT TEST

D146-286-10

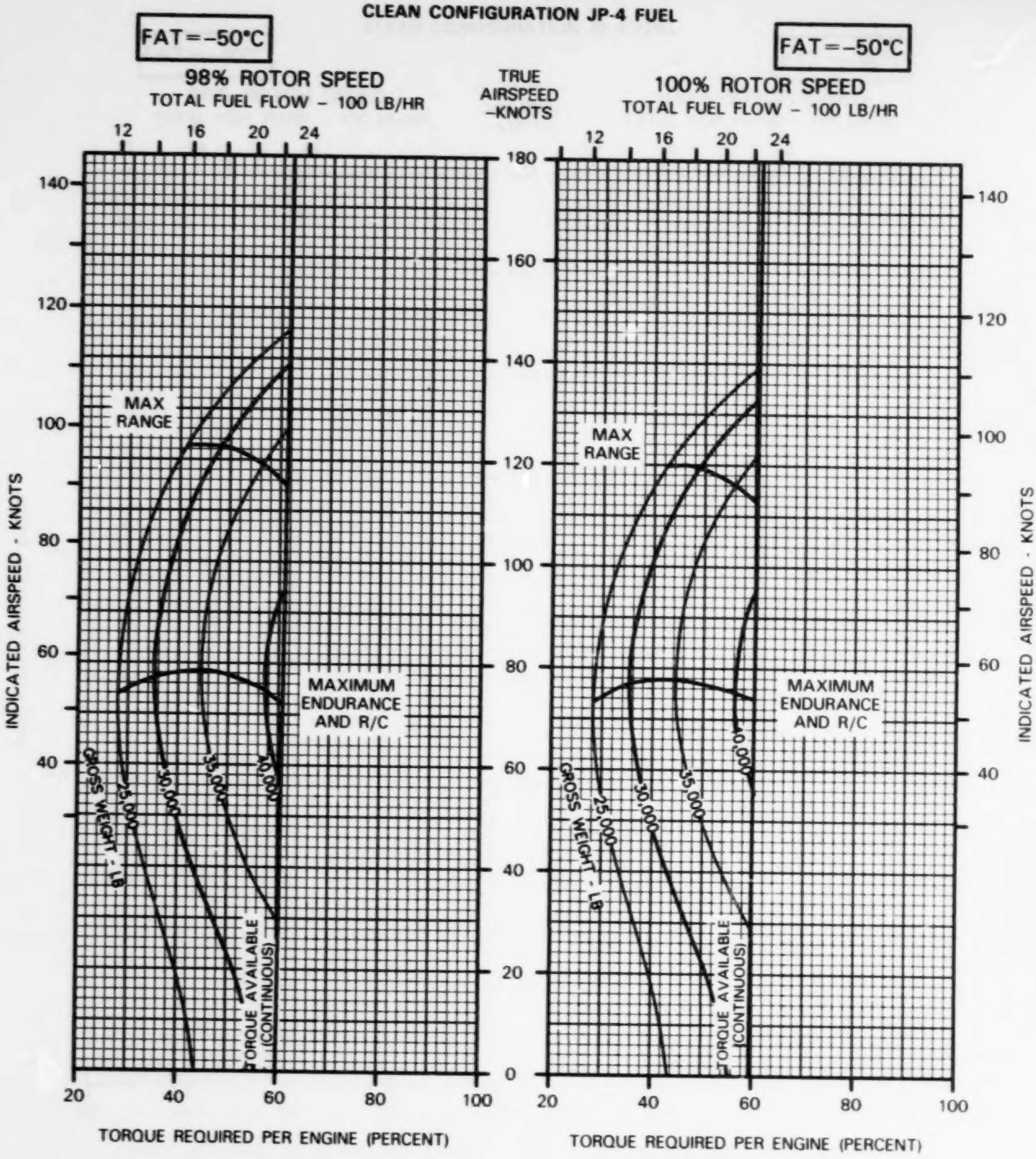
Figure 7-54. 100% Rotor RPM, 30° and 40°C, 16,000 Feet

CRUISE

PRESSURE ALTITUDE - 18,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

A9421

Figure 7-55. 98 and 100% Rotor RPM, -50°C, 18,000 Feet

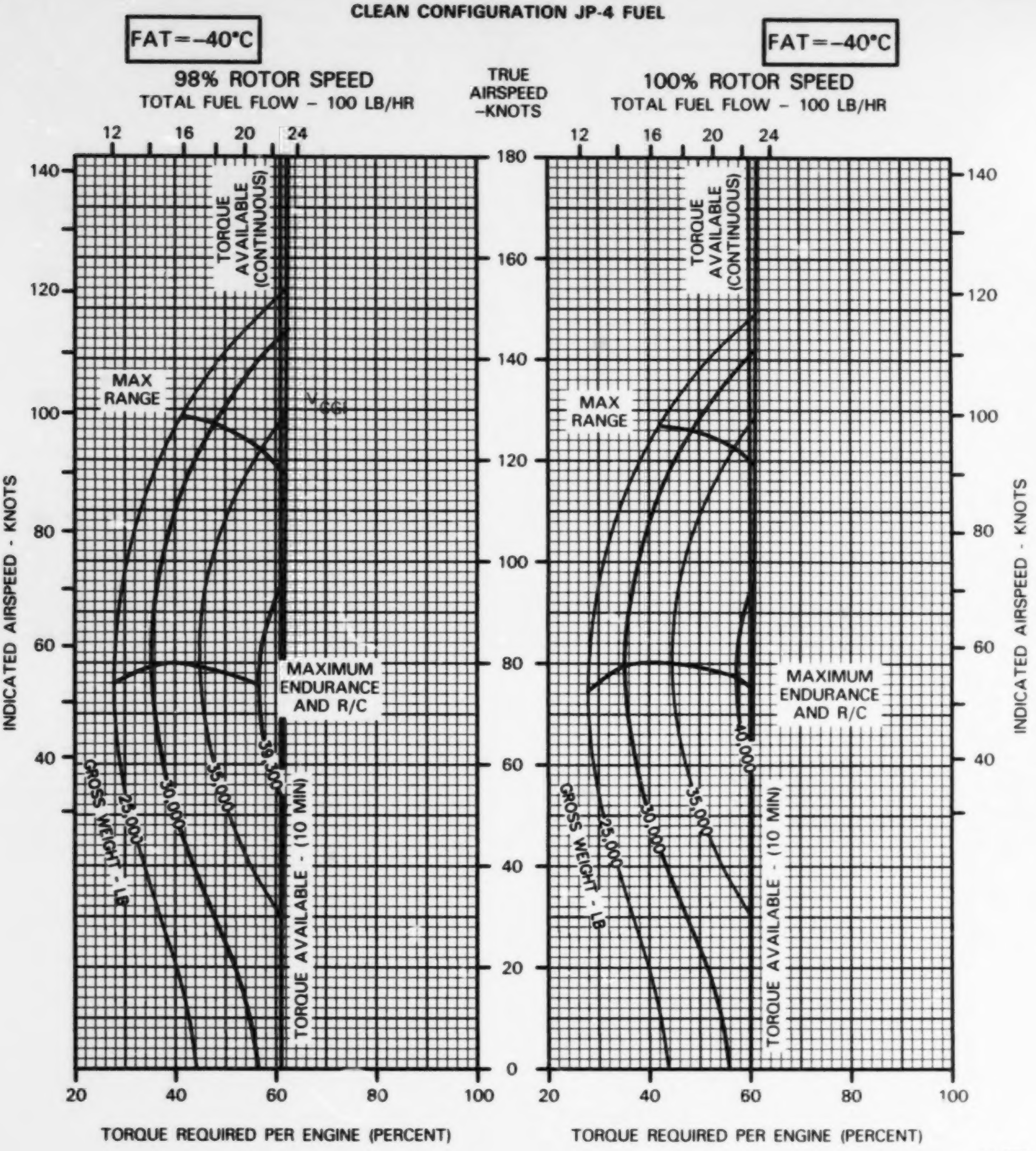
Y ☐
R ■

CRUISE

PRESSURE ALTITUDE - 18,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



Y ☐
R ■
A9422

DATA BASIS: FLIGHT TEST

Figure 7-55.1. 98 and 100% Rotor RPM, −40°C, 18,000 Feet

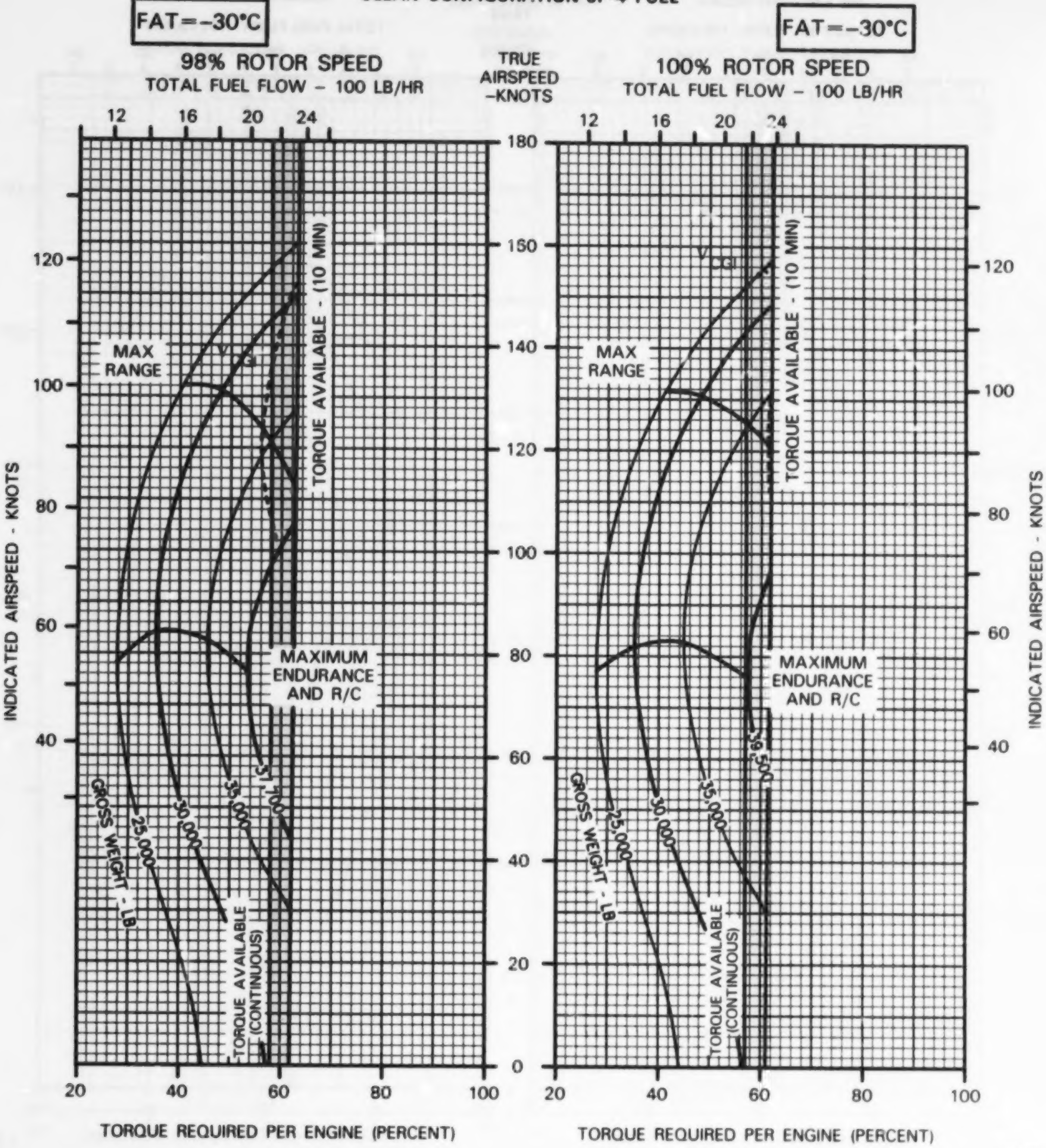
Y ☐
R ■

CRUISE
CH-47D
(2) T55-L-712

CRUISE

PRESSURE ALTITUDE - 18,000 FT

CLEAN CONFIGURATION JP-4 FUEL



Y ☐
R ▨

A9423

DATA BASIS: FLIGHT TEST

Figure 7-55.2. 98 and 100% Rotor RPM, -30°C, 18,000 Feet

■ R

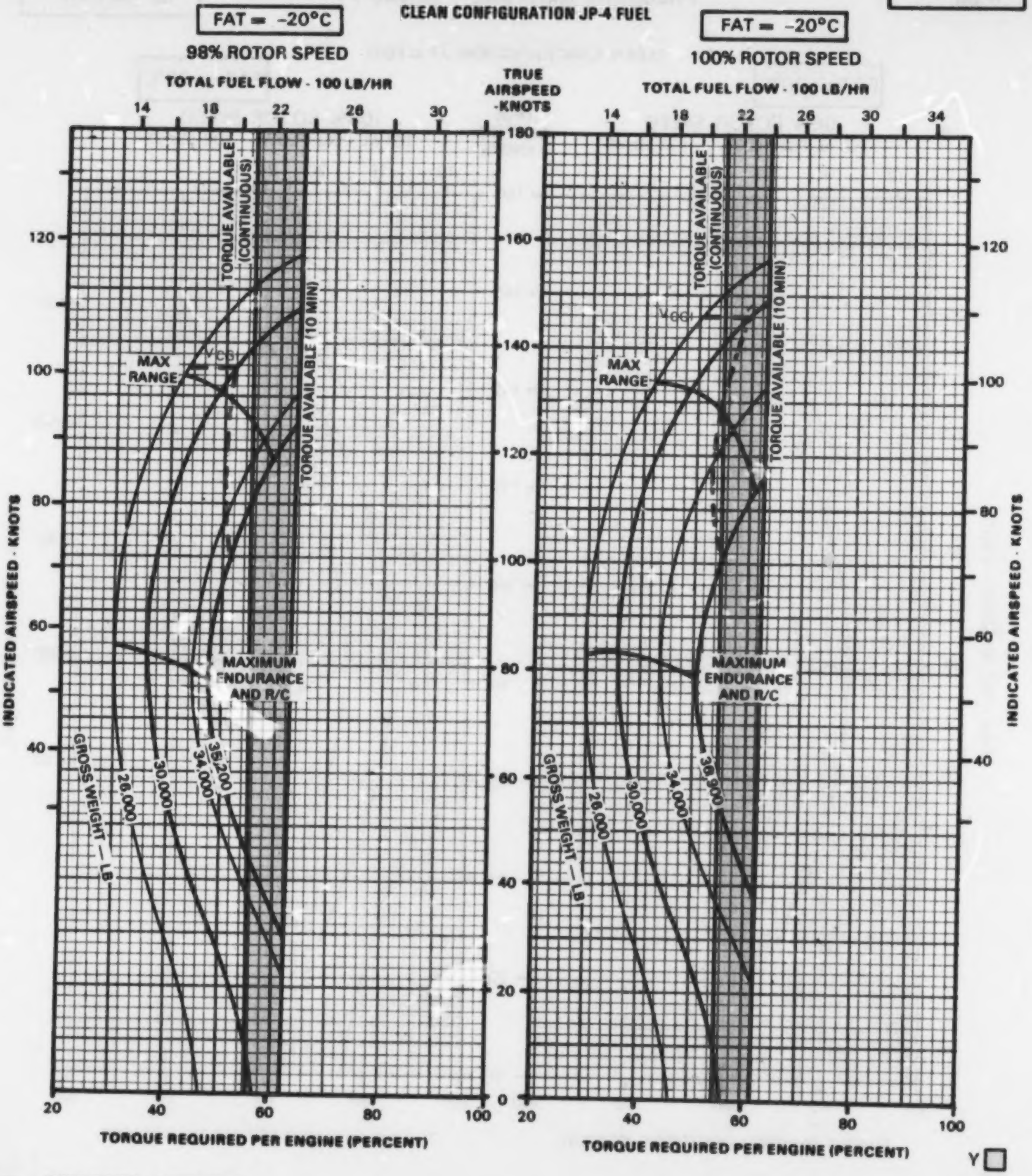
▨ Y

CRUISE

PRESSURE ALTITUDE — 18,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

D145-266-10

Figure 7-56. 98 and 100% Rotor RPM, -20°C, 18,000 Feet

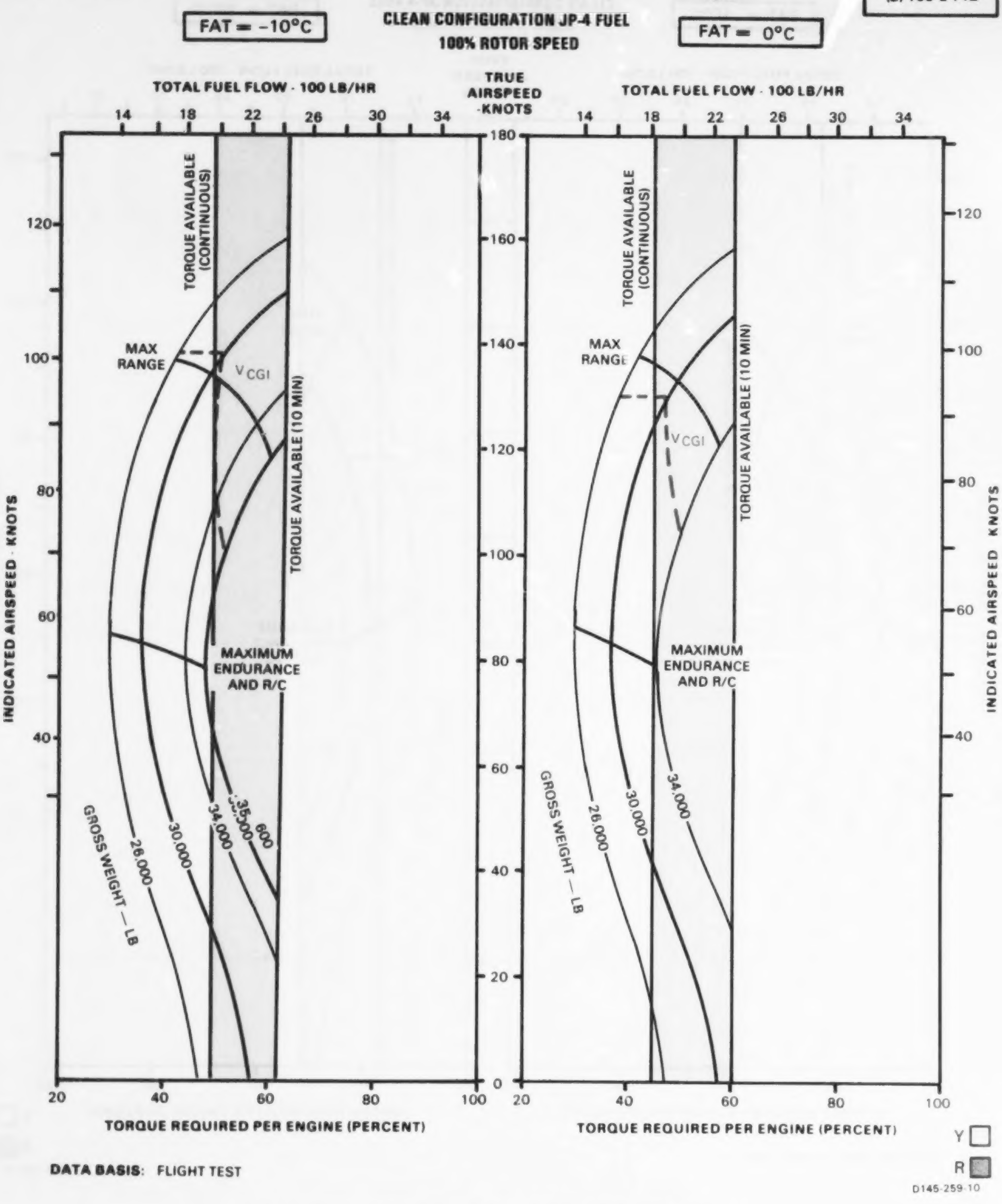
■ R
▨

CRUISE

PRESSURE ALTITUDE — 18,000 FT

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

CRUISE
CH-47D
(2) T55-L-712



Y ☐
R ▨

DATA BASIS: FLIGHT TEST

D145-259-10

Figure 7-57. 100% Rotor RPM, -10° and 0°C, 18,000 Feet

■ R

☐

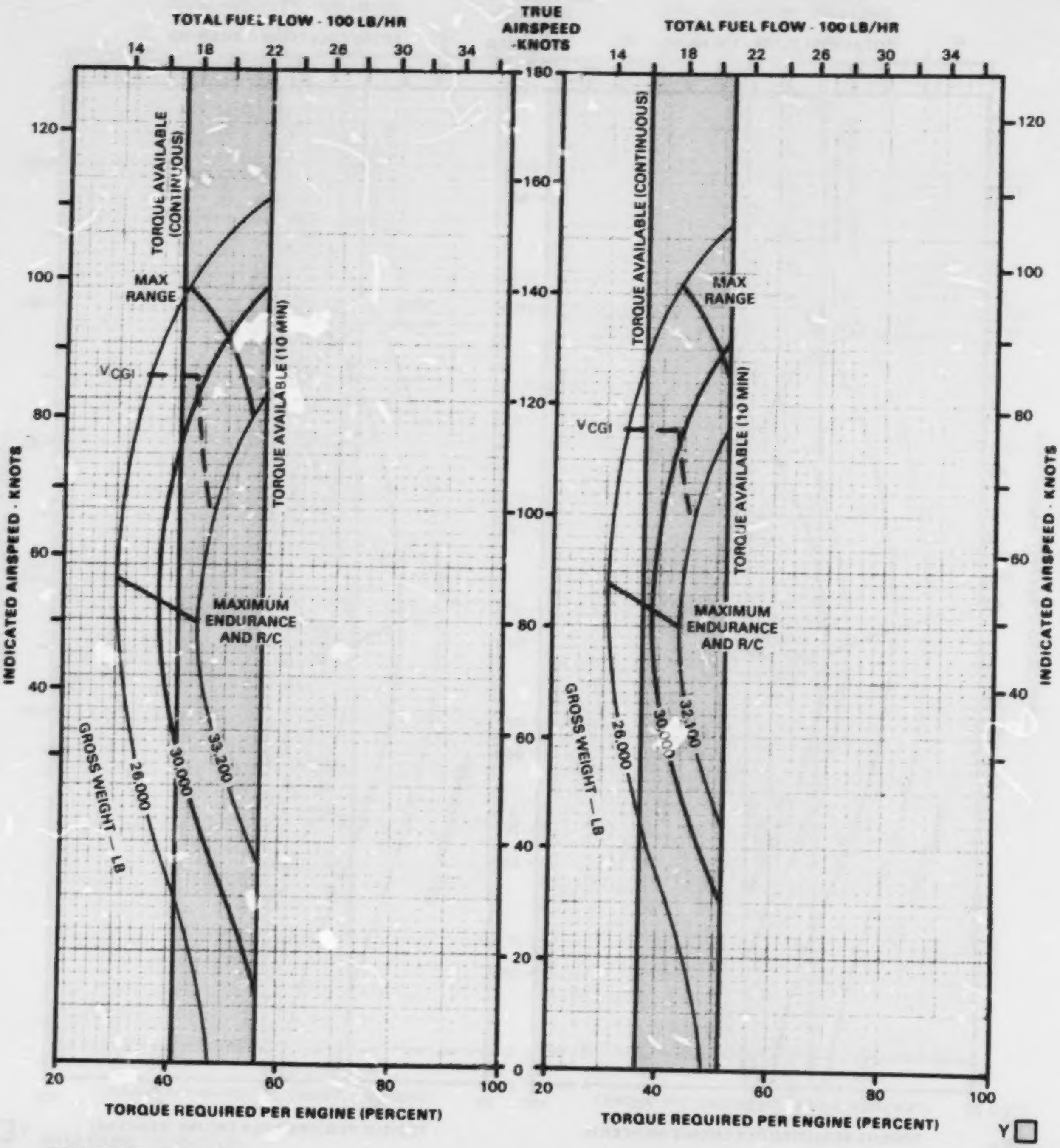
CRUISE
PRESSURE ALTITUDE — 18,000 FT

CRUISE
CH-47D
(2) T55-L-712

FAT = 10°C

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED

FAT = 20°C



Y ☐

R ■

DATA BASIS: FLIGHT TEST

D145-260-10

Figure 7-58. 100% Rotor RPM, 10° and 20°C, 18,000 Feet

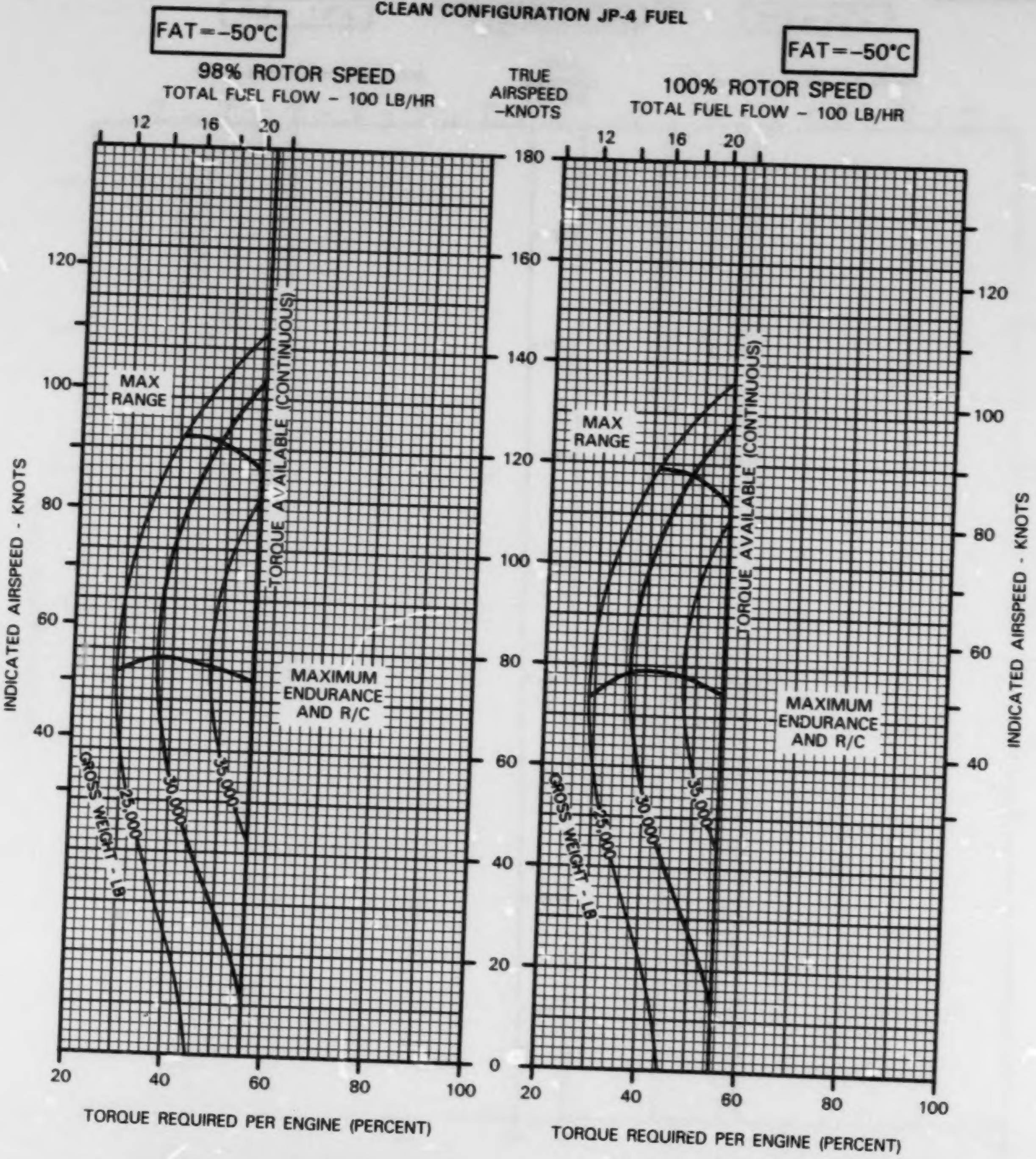
Figure 7-59. Deleted.

CRUISE

PRESSURE ALTITUDE - 20,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

A9424

Figure 7-60. 98 and 100% Rotor RPM, -50°C, 20,000 Feet

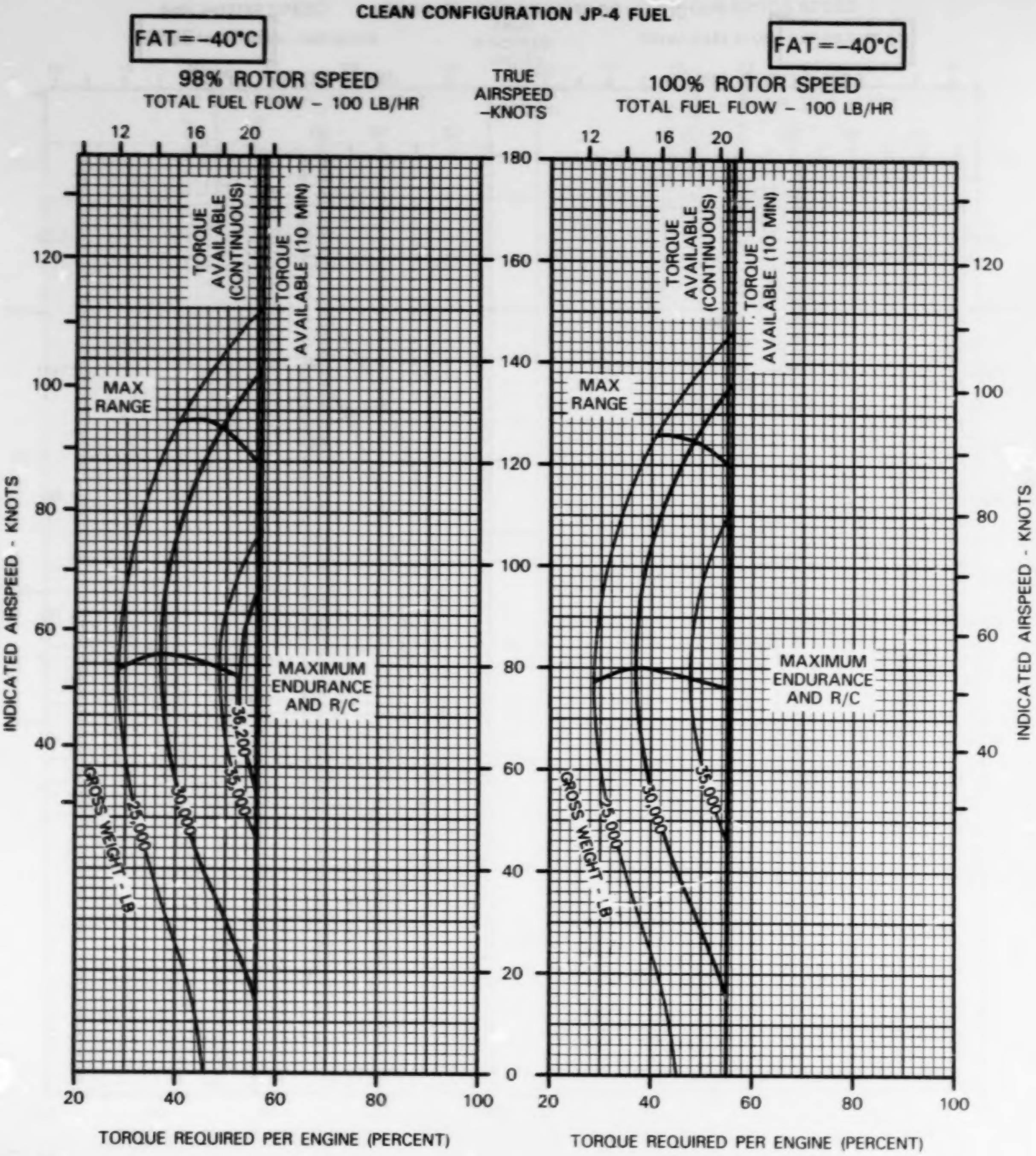
Y ☐

CRUISE

CRUISE
CH-47D
(2) T55-L-712

PRESSURE ALTITUDE - 20,000 FT

CLEAN CONFIGURATION JP-4 FUEL



Y ☐

DATA BASIS: FLIGHT TEST

A9425

Figure 7-60.1. 98 and 100% Rotor RPM, -40°C, 20,000 Feet

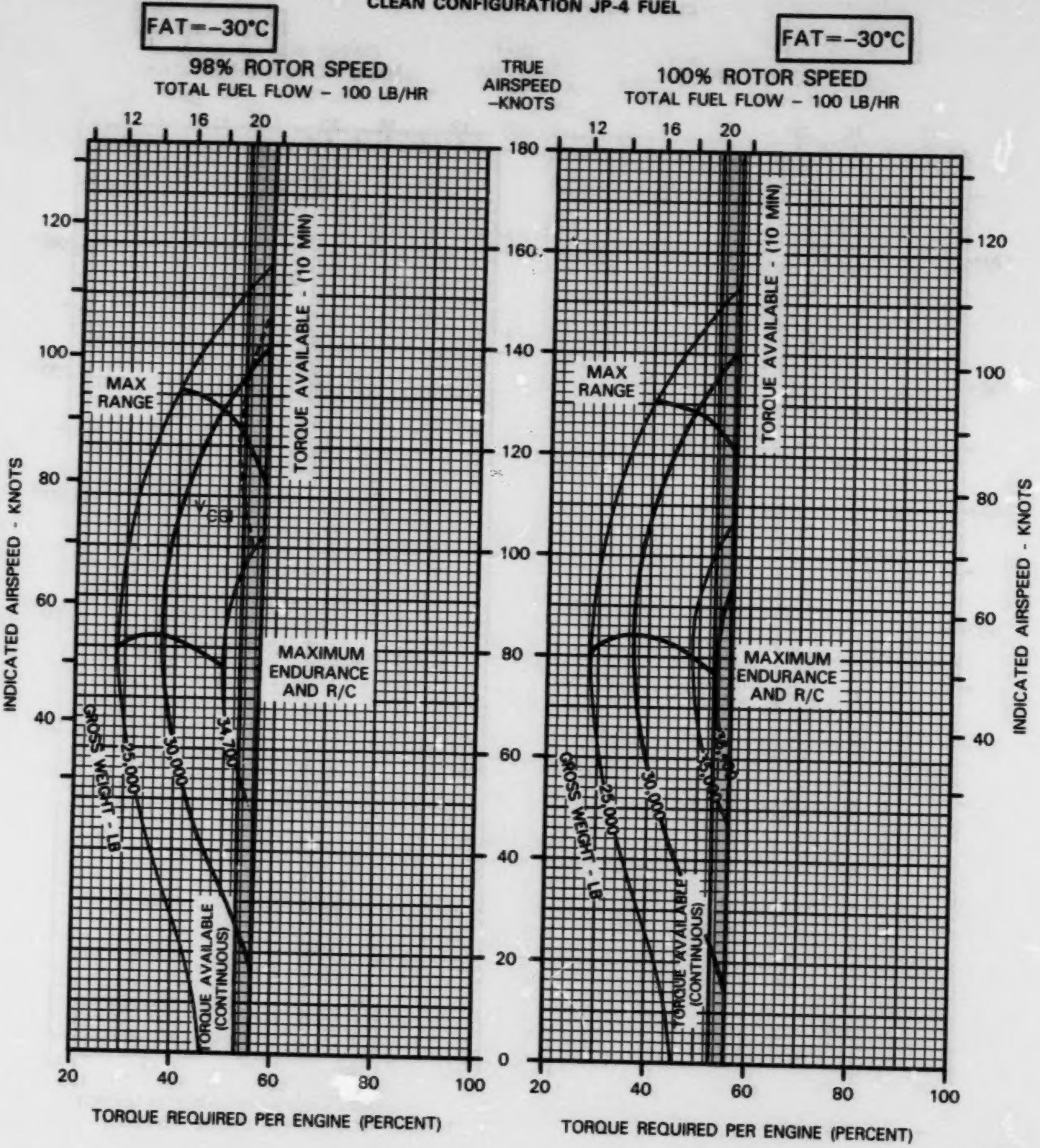
Y ☐
R ■

CRUISE

PRESSURE ALTITUDE - 20,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

Y ☐
R ■

A9426

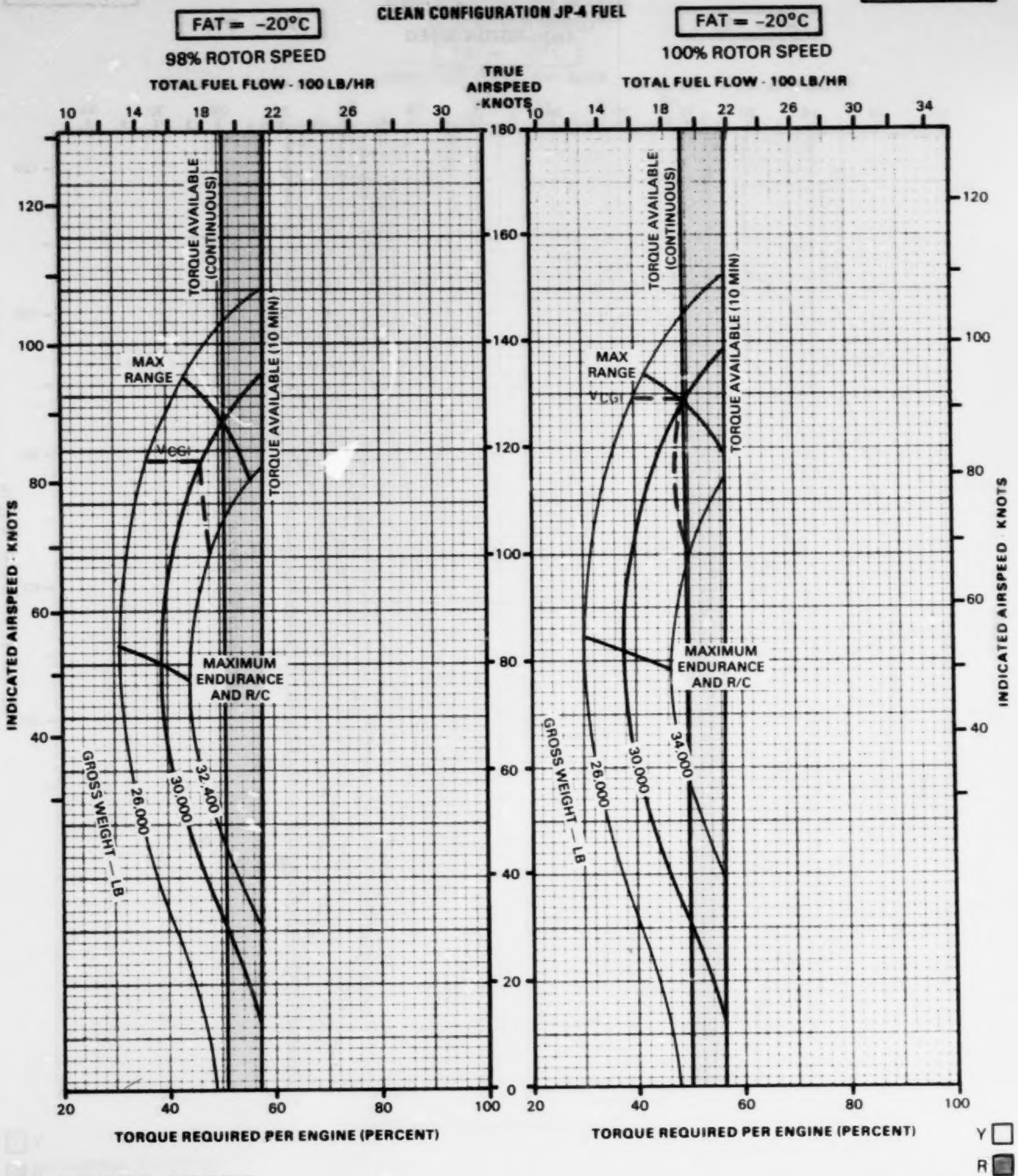
Figure 7-60.2. 98 and 100% Rotor RPM, -30°C, 20,000 Feet

R ■
▨

CRUISE
PRESSURE ALTITUDE — 20,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL



DATA BASIS: FLIGHT TEST

D145-263-10

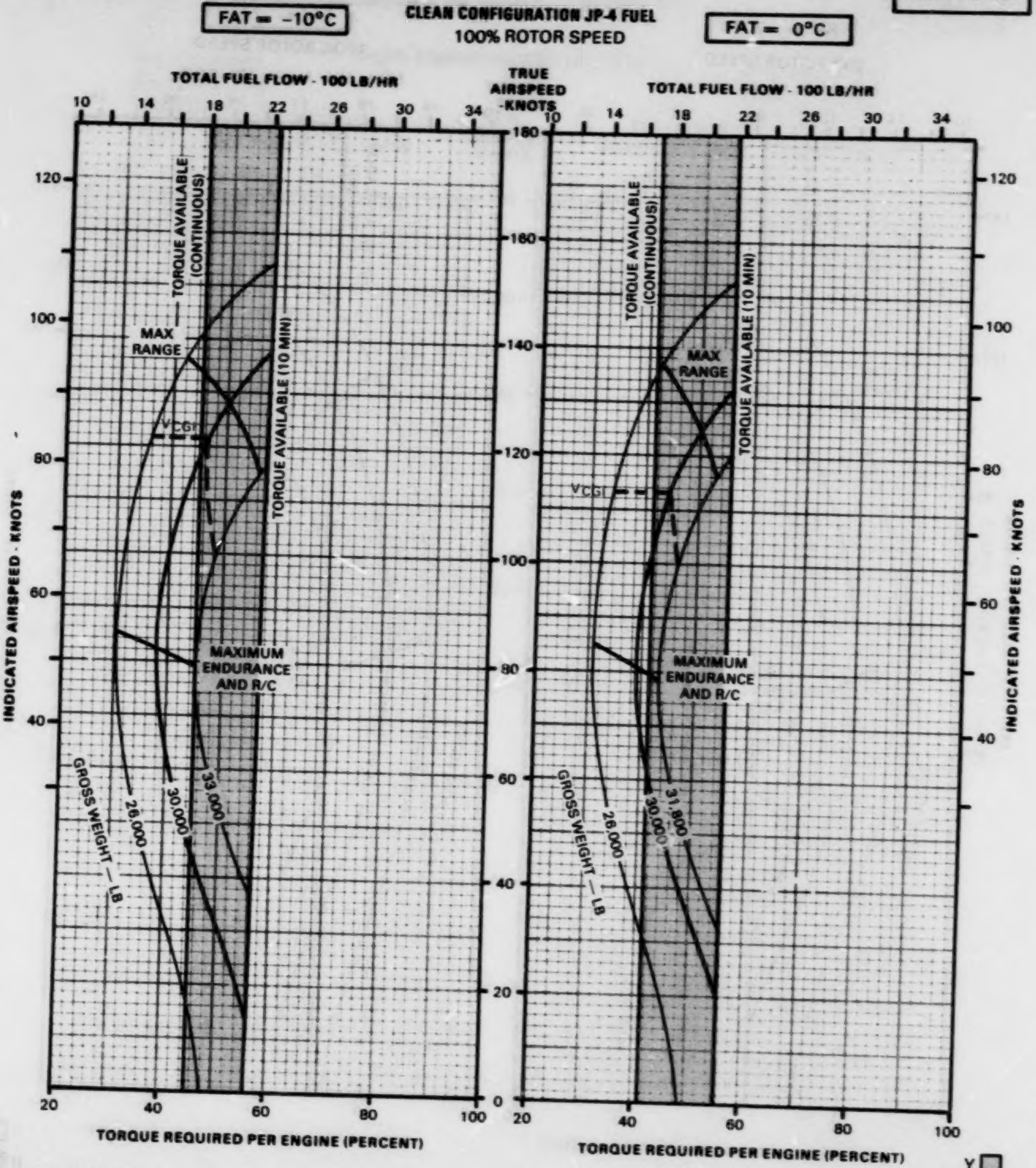
Figure 7-61. 98 and 100% Rotor RPM, -20°C, 20,000 Feet

■ R
▨

CRUISE
PRESSURE ALTITUDE — 20,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED



DATA BASIS: FLIGHT TEST

Y ▨
R ■

D145-264-10

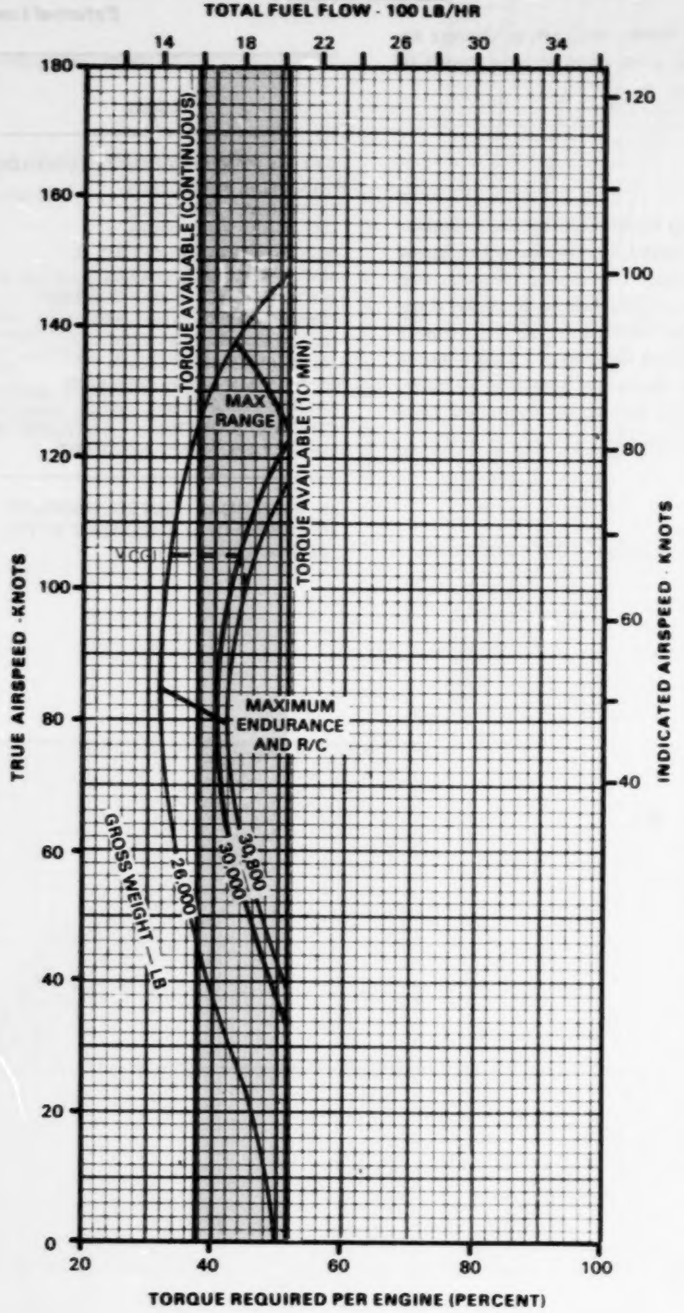
Figure 7-62. 100% Rotor RPM, -10° and 0°C, 20,000 Feet

■ R
▨ Y

CRUISE
PRESSURE ALTITUDE — 20,000 FT

CRUISE
CH-47D
(2) T55-L-712

CLEAN CONFIGURATION JP-4 FUEL
100% ROTOR SPEED
FAT = 10°C



DATA BASIS: FLIGHT TEST

Y ☐
R ▨

D145-265-10

Figure 7-63. 100% Rotor RPM, 10° and 20°C, 20,000 Feet

SECTION IX DRAG

7-32. Description.

The drag chart (figure 7-64) shows the torque change required for flight due to drag area change as a result of external configuration changes.

7-33. Use of Charts.

The primary use of the chart is illustrated by the example. To determine the change in torque, it is necessary to know the drag area change, true airspeed, pressure altitude, and free air temperature. From the table below find the drag area change associated with the configuration, or estimate if necessary. Enter chart at known drag area change, move right to true airspeed, move down to pressure altitude, move left to free air temperature, then move down and read change in engine torque.

7-34. Conditions.

The drag chart is based on operating at 100% rotor rpm.

Table 7-1. Change in Drag Area of Typical External Loads

LOAD	DRAG AREA CHANGE FT^2
8 FT X 8 FT X 20 FT CONEX CONTAINER	150/100(1)
(2) 500 GAL FUEL CELLS	40
(3) 500 GAL FUEL CELLS	60
(4) 500 GAL FUEL CELLS	80
M35-2½ TON CARGO TRUCK	80
M37-¾ TON CARGO TRUCK	60
HMMWV (ENCLOSED VEHICLE)	49/28(1)
HMMWV(TOW LAUNCHER)	54/31(1)
M2A1-105MM HOWITZER	50
M102-105MM HOWITZER	50
M198-155MM HOWITZER GUN	149/50(1)
OH-6 HELICOPTER	40(2)
CH-47 HELICOPTER	230(2)
OV-10 FIXED WING AIRCRAFT	80(2)

(1) WITH DUAL POINT SUSPENSION
(2) RIGGED IN ACCORDANCE WITH FM55-413, JAN 1976

DATA BASIS:
ESTIMATED/
FLIGHT TEST

G ■

DRAG
100% ROTOR RPM

DRAG
CH-47D
T55-L-712

EXAMPLE

WANTED

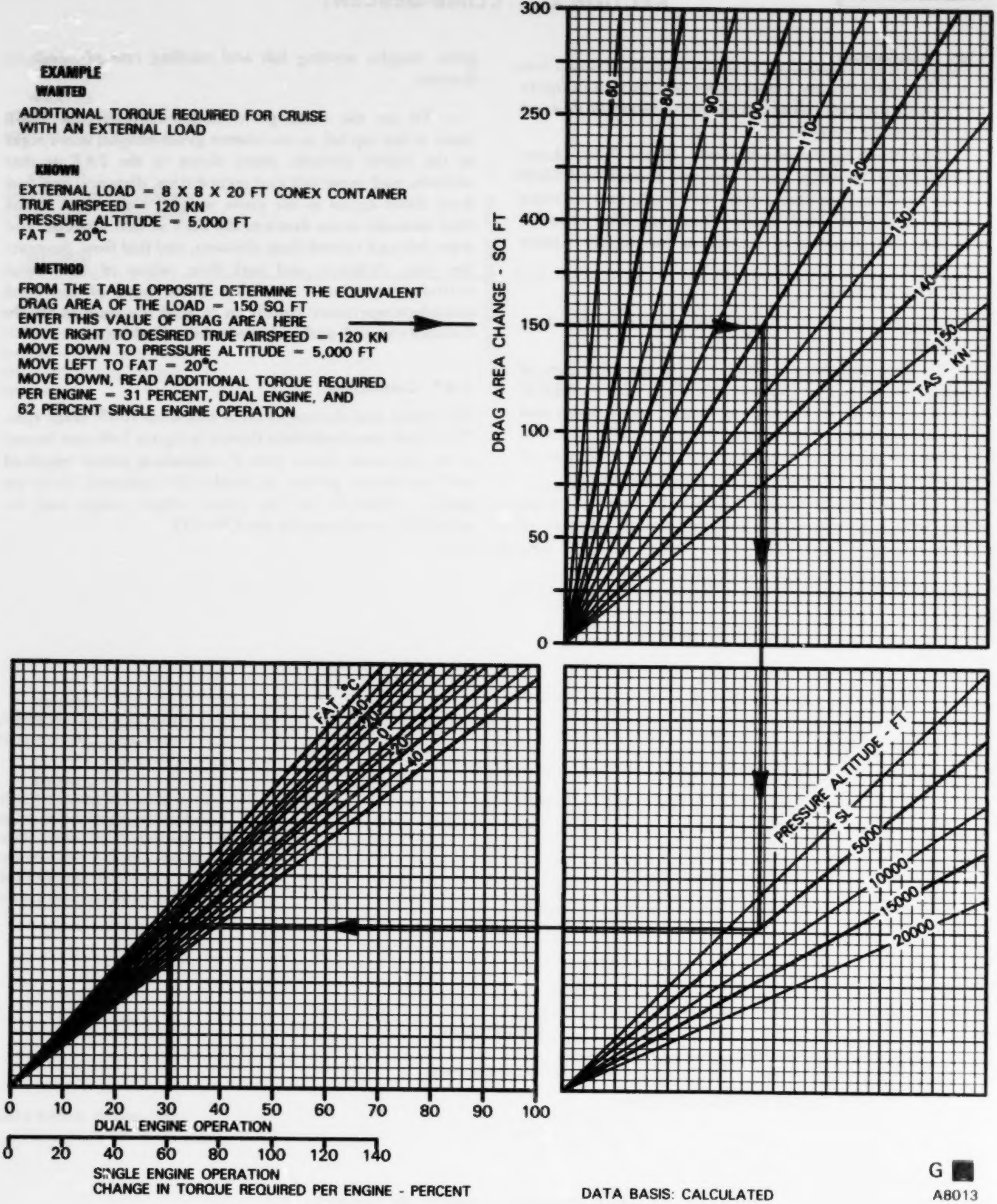
ADDITIONAL TORQUE REQUIRED FOR CRUISE WITH AN EXTERNAL LOAD

KNOWN

EXTERNAL LOAD = 8 X 8 X 20 FT CONEX CONTAINER
TRUE AIRSPEED = 120 KN
PRESSURE ALTITUDE = 5,000 FT
FAT = 20°C

METHOD

FROM THE TABLE OPPOSITE DETERMINE THE EQUIVALENT DRAG AREA OF THE LOAD = 150 SQ FT
ENTER THIS VALUE OF DRAG AREA HERE
MOVE RIGHT TO DESIRED TRUE AIRSPEED = 120 KN
MOVE DOWN TO PRESSURE ALTITUDE = 5,000 FT
MOVE LEFT TO FAT = 20°C
MOVE DOWN, READ ADDITIONAL TORQUE REQUIRED PER ENGINE = 31 PERCENT, DUAL ENGINE, AND 62 PERCENT SINGLE ENGINE OPERATION



DATA BASIS: CALCULATED

G ■
A8013

Figure 7-64. Drag Chart

SECTION X CLIMB-DESCENT

7-35. Description.

a. Climb and descent performance may be seen in figure 7-65, which presents change in torque to climb or descend at selected gross weights.

b. The climb performance chart, figure 7-66, shows relationships between gross weight, initial and final altitude and temperatures; time to climb, and distance covered and fuel used while climbing. The chart is presented for climbing at maximum torque (30 minute operation).

7-36. Use of Charts.

The primary uses of the charts is illustrated by the chart examples.

a. To determine torque change for a specified rate of climb or rate of descent (figure 7-65), enter rate of climb or descent and move right to gross weight, move down and read torque change. This torque change must be added to the torque required for level flight for climb, or subtracted for descent, to obtain total climb or descent torque.

b. Rate of climb or descent may also be obtained by entering with a known torque change, moving upward to gross weight, moving left and reading rate of climb or descent.

c. To use the climb performance chart (figure 7-66), enter at the top left at the known gross weight, move right to the initial altitude, move down to the FAT at that altitude, and move left and record time, distance, and fuel flow. Enter again at the gross weight, move right to the final altitude, move down to the FAT at that altitude, and move left and record time, distance, and fuel flow. Subtract the time, distance, and fuel flow values of the initial altitude-temperature condition from those of the final altitude-temperature condition to find the time to climb, distance covered, and fuel used while climbing.

7-37. Conditions.

The climb and descent chart is based on 100% rotor rpm. The climb speed schedule shown in figure 7-66 (see insert) is for optimum climb, that is, minimum power required and maximum power available (30 minutes). It is an average schedule for the gross weight range and atmospheric conditions for the CH-47D.

G

CLIMB/DESCENT

100% ROTOR RPM

CLIMB/DESCENT
CH-47D
(2) T55-L-712

EXAMPLE

WANTED

TORQUE CHANGE REQUIRED FOR DESIRED R/C OR R/D

KNOWN

GROSS WEIGHT = 50000 LB
DESIRED R/C = 2,000 FPM

METHOD

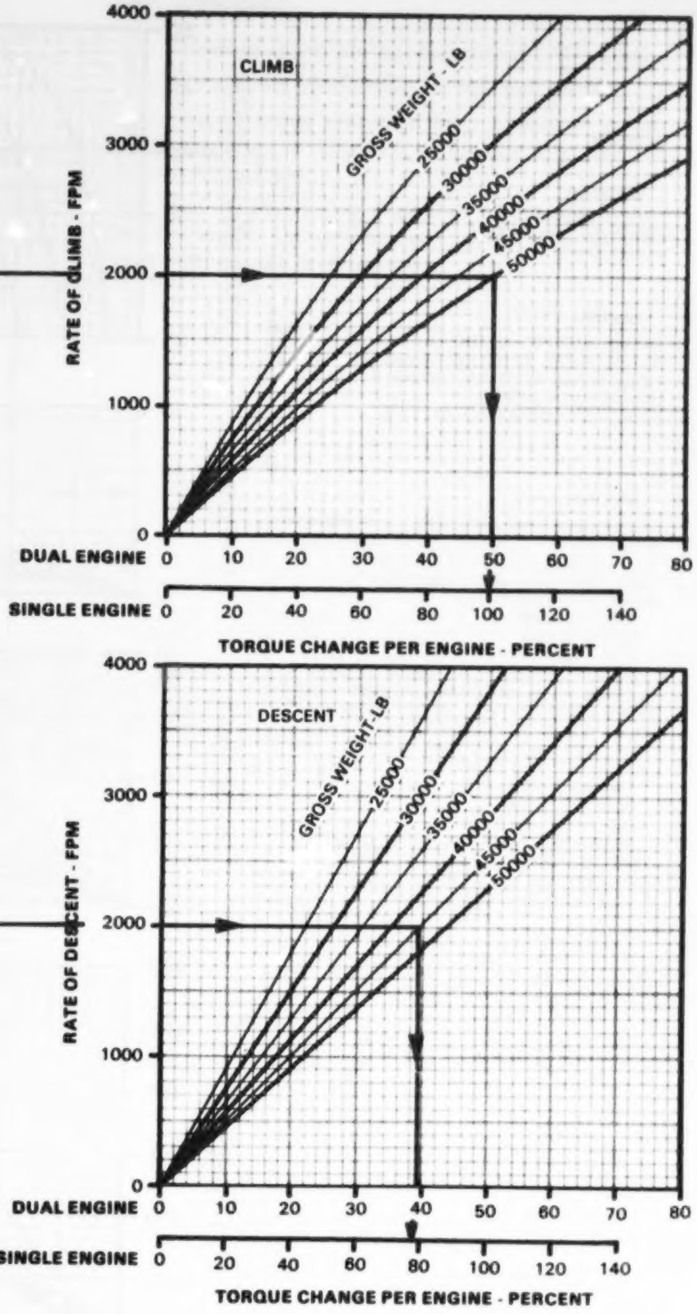
ENTER DESIRED R/C HERE MOVE RIGHT TO GROSS WEIGHT MOVE DOWN. READ TORQUE CHANGE PER ENGINE = 50% DUAL ENGINE AND 100% SINGLE ENGINE OPERATION

KNOWN

GROSS WEIGHT = 45000 LB
DESIRED R/D = 2000 FPM

METHOD

ENTER DESIRED R/D HERE MOVE RIGHT TO GROSS WEIGHT MOVE DOWN. READ TORQUE CHANGE PER ENGINE = 39.0% DUAL ENGINE AND 78.0% SINGLE ENGINE OPERATION.



DATA BASIS: FLIGHT TEST

G

D145-288-10

Figure 7-65. Climb — Descent Chart

G ■

CLIMB PERFORMANCE
INTERMEDIATE TORQUE - 30 MIN OPERATION

100% ROTOR RPM - CLIMB SPEED (SEE INSERT BELOW)

CLIMB
CH47-D
(2) T55-L-712

EXAMPLE

WANTED

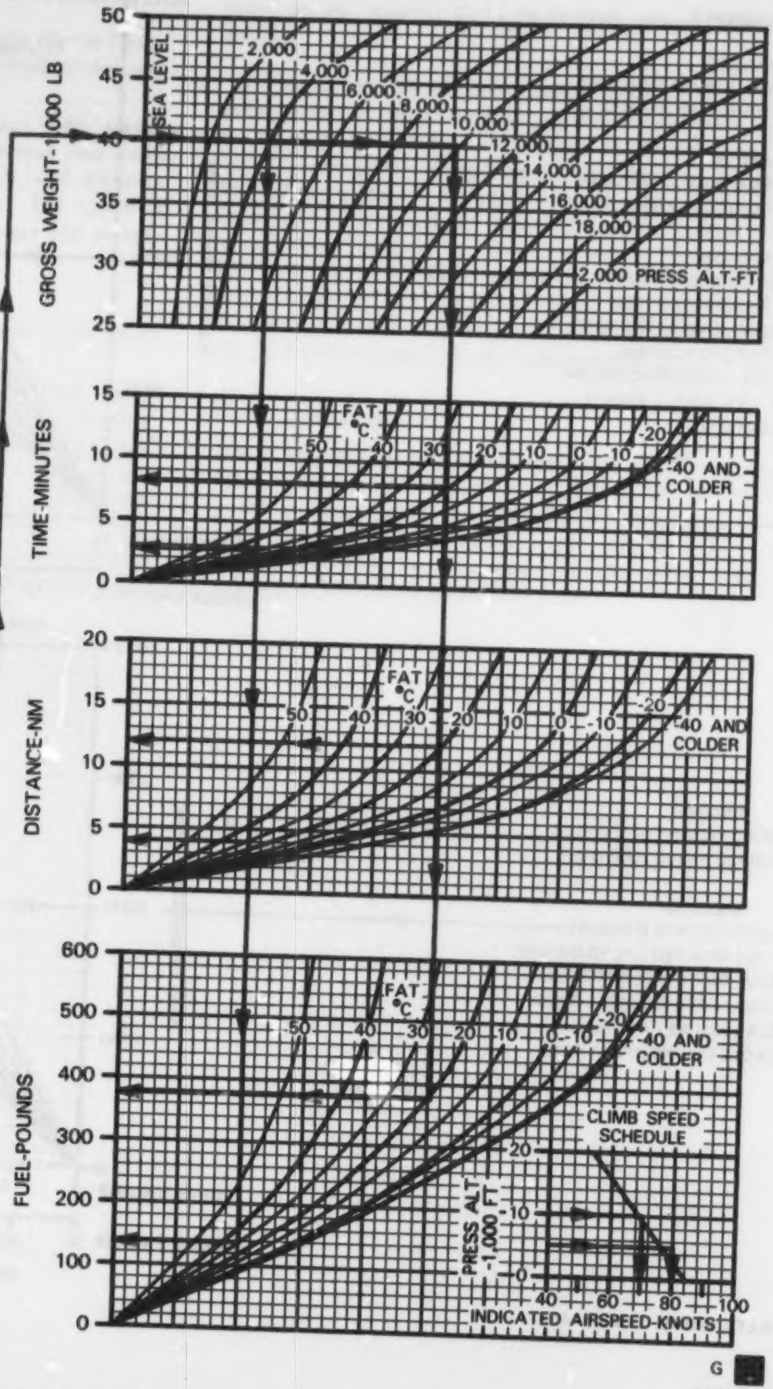
TIME TO CLIMB
DISTANCE TRAVELED
CLIMB SPEED

KNOWN

GROSS WEIGHT=40,000 LB
INITIAL PRESS ALTITUDE=4,000 FT
FINAL PRESS ALTITUDE=10,000 FT
INITIAL FAT=30°C
FINAL FAT ESTIMATED AT 18°C

METHOD

ENTER GROSS WEIGHT HERE
MOVE RIGHT TO INITIAL PRESS ALTITUDE
MOVE DOWN TO INITIAL FAT ON
TIME, DISTANCE AND FUEL CHARTS
MOVE LEFT AND READ:
TIME=2.7 MIN
DIST=3.8 NM
FUEL=140 LB
SPEED=79 KNOTS IAS (FROM INSERT)
REENTER AT SAME GROSS WEIGHT
MOVE RIGHT TO FINAL PRESS ALTITUDE
MOVE DOWN TO FINAL FAT ON
TIME, DISTANCE AND FUEL CHARTS
MOVE LEFT AND READ:
TIME=7.2 MIN
DIST=11.0 NM
FUEL=362 LB
SPEED=70 KNOTS IAS (FROM INSERT)
TIME TO CLIMB=(7.2-2.7)=4.5 MIN
DIST COVERED=(11.0-3.8)=7.2 NM
FUEL USED=(362-140)=222 LB



DATA BASIS: FLIGHT TEST

G ■
A10125

Figure 7-66. Climb Performance

SECTION XI FUEL FLOW

7-38. Description.

The idle fuel flow chart (figure 7-67) presents engine fuel flow sensitivity to pressure altitude and free air temperature for ground idle and flight idle.

7-39. Use of Chart.

The primary use of the charts is illustrated by the example. To determine idle fuel flow, it is necessary to know idle condition, pressure altitude, and free air temperature. Enter pressure altitude, move right to free air temperature, move down and read fuel flow.

7-40. Conditions.

a. Presented charts are based on the use of JP-4 fuel.

b. Ground idle is defined at 60 to 63 percent N1.

c. Ground detent minimum beep is defined as engine condition levers at FLIGHT, minimum beep, and thrust control at the detent.

d. The single engine fuel flow chart (figure 7-68) baseline is 0°C. Increase or decrease fuel flow by 1% for every 10°C change in temperature.

IDLE FUEL FLOW

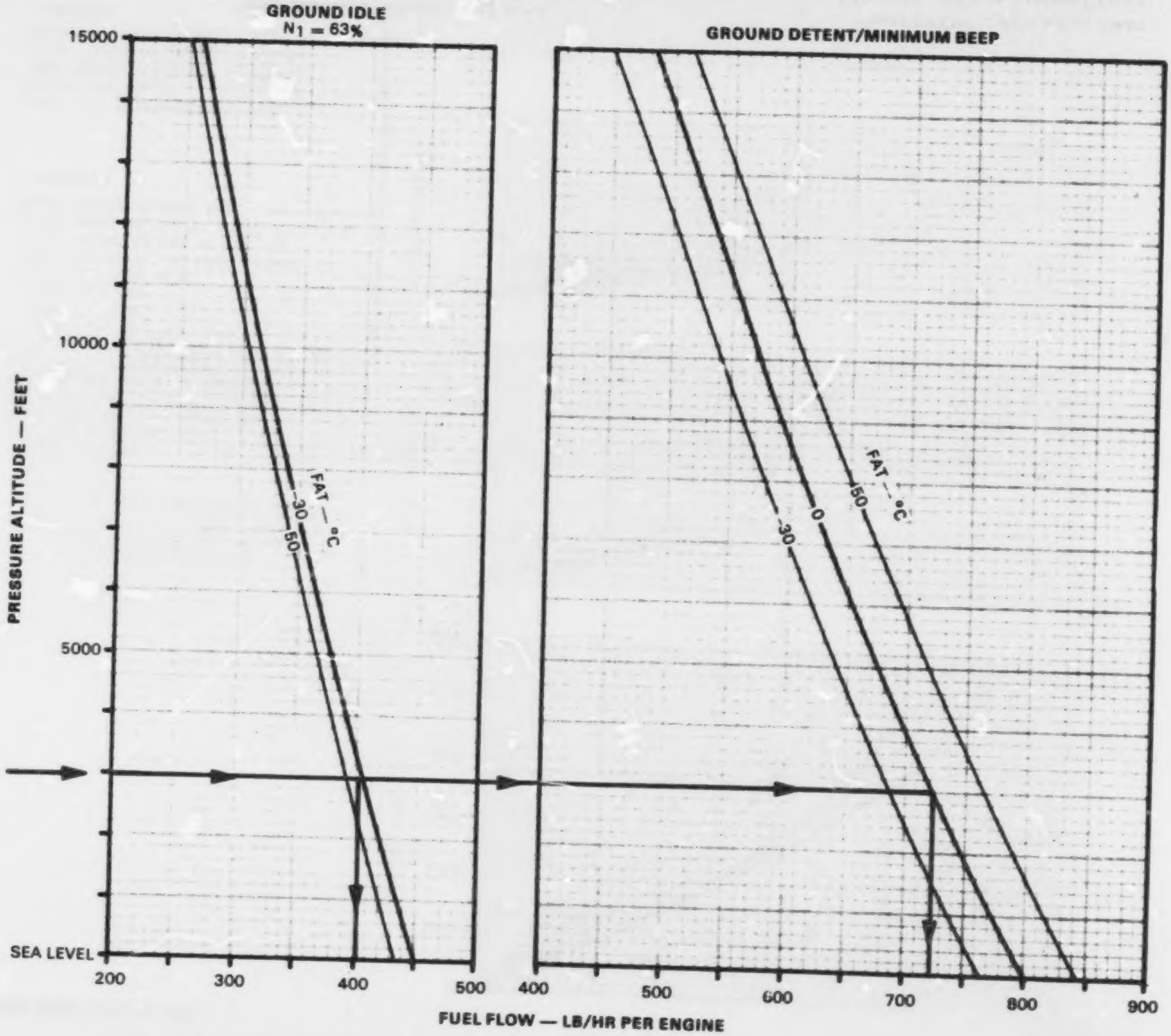
JP-4 FUEL

IDLE FUEL FLOW
CH-47D
T55-L-712

WANTED
IDLE FUEL FLOW AT GROUND IDLE AND MINIMUM BEEP

KNOWN
PRESSURE ALTITUDE = 3000 FT/FAT = 0°C

METHOD
ENTER PRESSURE ALTITUDE AT 3000 FT. MOVE RIGHT TO FAT. FOR GROUND IDLE AND MINIMUM BEEP MOVE DOWN. READ GROUND IDLE FUEL FLOW = 400 LB/HR PER ENGINE AND MINIMUM BEEP FUEL FLOW = 720 LB/HR PER ENGINE



DATA BASIS: CALCULATED FROM MODEL SPEC. NO. 124.53(A)

G

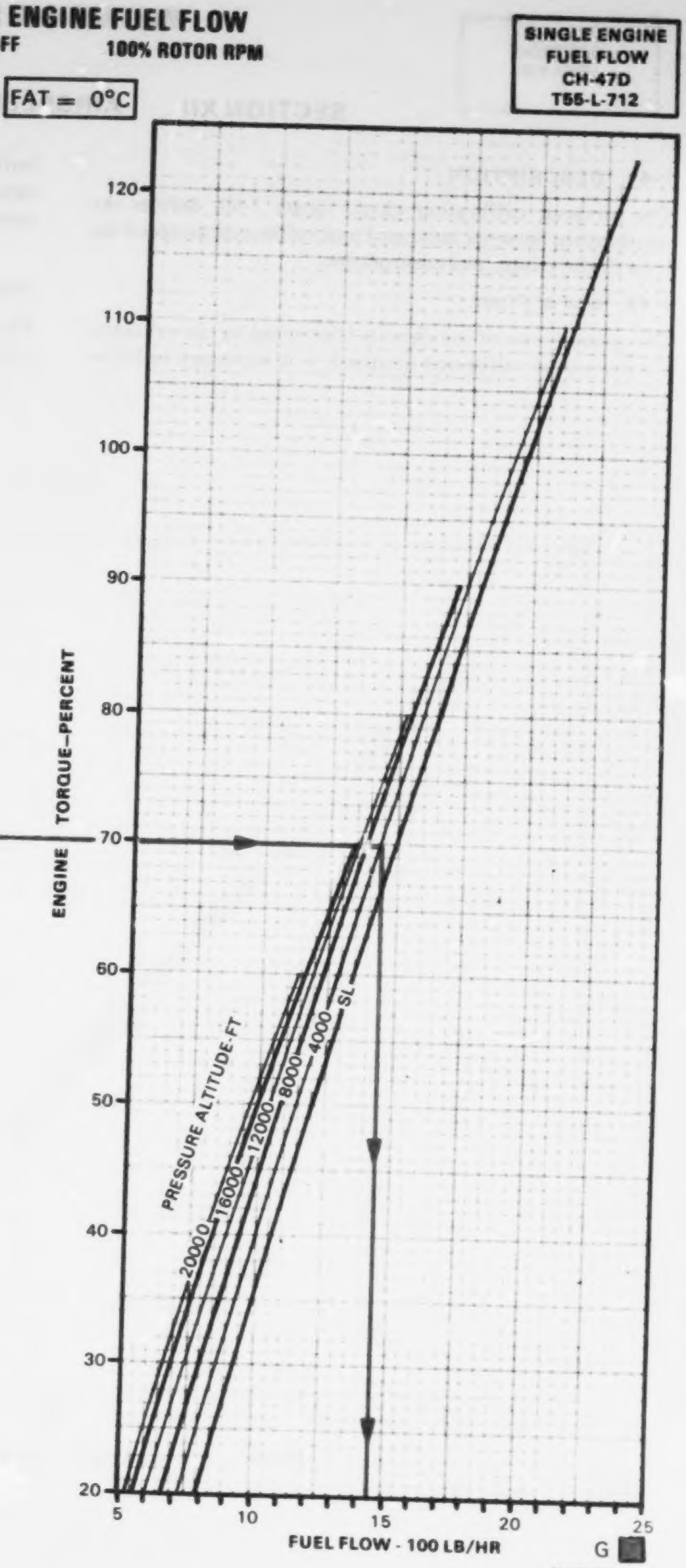
D145-270-10

Figure 7-67. Idle Fuel Flow Chart

G

SINGLE ENGINE FUEL FLOW

BLEED-AIR OFF 100% ROTOR RPM



EXAMPLE

WANTED
SINGLE-ENGINE FUEL FLOW

KNOWN
TORQUE = 70%
PRESSURE ALTITUDE = 4000 FEET
FAT = 10°C

METHOD
ENTER AT 70% TORQUE HERE
MOVE RIGHT TO 4000 FEET
PRESSURE ALTITUDE, THEN DOWN
AND READ 1430 LB/HR FUEL FLOW.
SINCE FAT IS 10° ABOVE THE
BASELINE OF THIS CHART,
INCREASE FUEL FLOW BY 1%
FOR EVERY 10°C
1430 x .01 = 14.3 POUNDS/HR
1430 + 14.3 = 1444.3 POUNDS/HR

NOTE:
BASELINE IS 0°C
INCREASE OR DECREASE FUEL
FLOW BY 1% FOR EVERY
10°C CHANGE IN TEMP.

DATA BASIS: CALCULATED

Figure 7-68. Single Engine Fuel Flow Chart

SECTION XII AIRSPEED CALIBRATION

7-41. DESCRIPTION.

The airspeed calibration chart, figure 7-69, defines the relationship between indicated and calibrated airspeed for level flight, climb, and autorotation.

7-42. Use of Chart.

The primary use of the chart is illustrated by the example. To determine calibrated airspeed, it is necessary to know indicated airspeed and flight regime. Enter chart at indicated airspeed, move right to appropriate flight regime, move down and read calibrated airspeed.

7-43. Conditions.

Presented airspeed calibration charts are for CH-47D helicopters with T55-L-712 engines.

AIRSPEED CALIBRATION

EXAMPLE

WANTED

CALIBRATED AIRSPEED

KNOWN

INDICATED AIRSPEED = 70 KNOTS

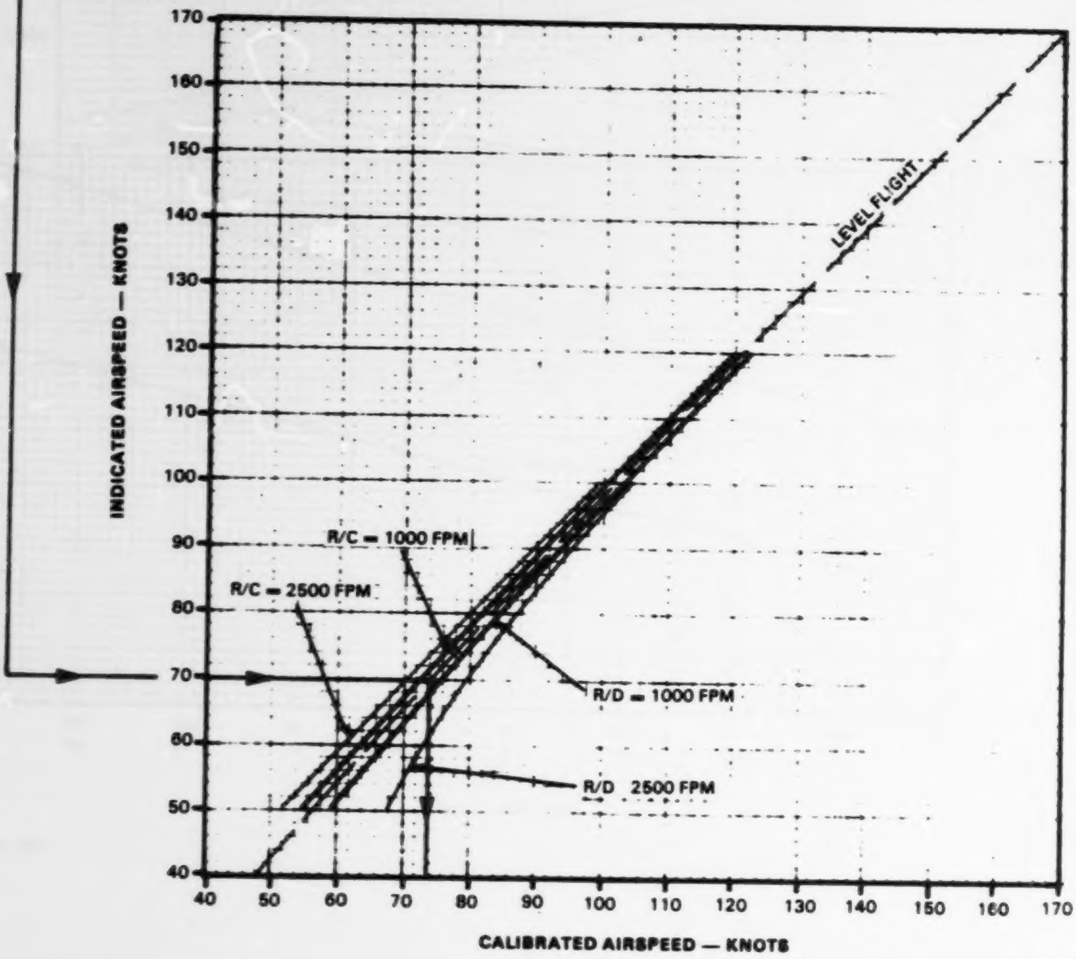
FLIGHT CONDITION = LEVEL FLIGHT

METHOD

ENTER INDICATED AIRSPEED HERE

MOVE RIGHT TO FLIGHT CONDITION

MOVE DOWN, READ CALIBRATED AIRSPEED = 74 KNOTS



DATA BASIS: FLIGHT TEST

D148-271-10

Figure 7-69. Airspeed Calibration Chart

SECTION XIII ACCUMULATOR PRECHARGE LIMITS

7-44. Description.

The accumulator precharge limits charts, figures 7-70 and 7-71, depicts the relationship between proper accumulator precharge and ambient temperature.

7-45. Use of Chart.

To check that an accumulator is properly precharged, read free air temperature from the FAT gage. Enter the bottom of the chart at the indicated temperature and move vertically to the pressure indicated on the accumulator pressure gage. If the indicated pressure is within the minimum and maximum limits, the accumulator is properly precharged. If the indicated pressure is not within limits, service the accumulator. Refer to Chapter 2.

7-46. Conditions.

Presented charts are for CH-47D helicopters.

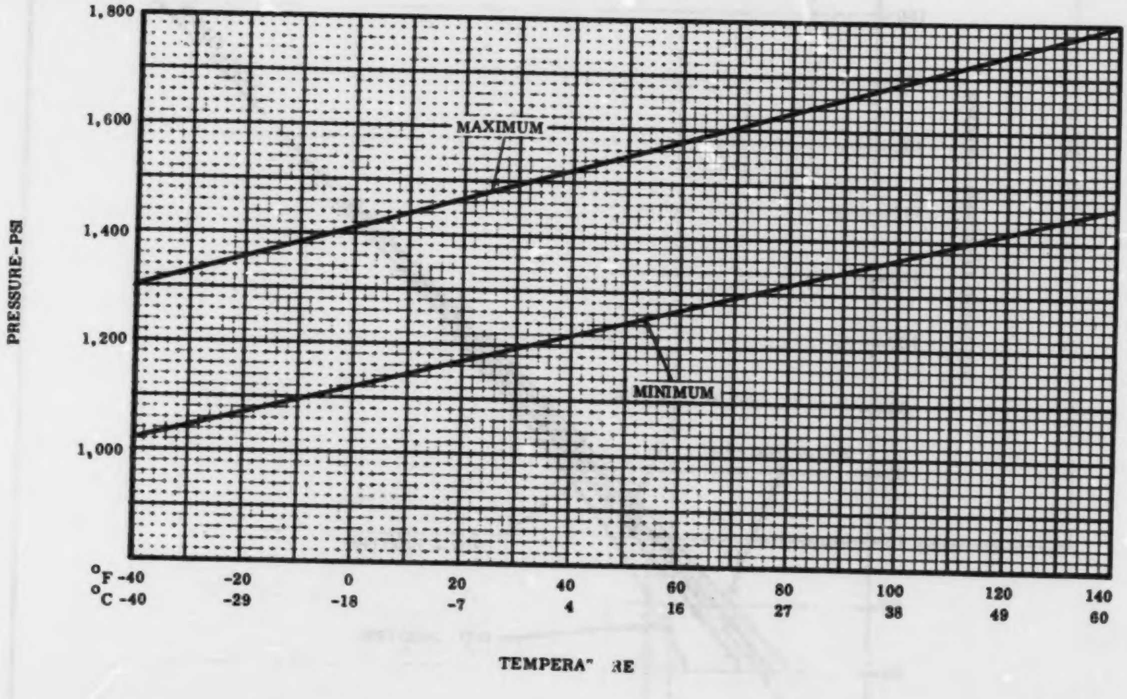


Figure 7-70. Flight Control, Utility System, Power Steering, and Signal Accumulators Precharge Limits

Pages 7-89 and 7-90 deleted.

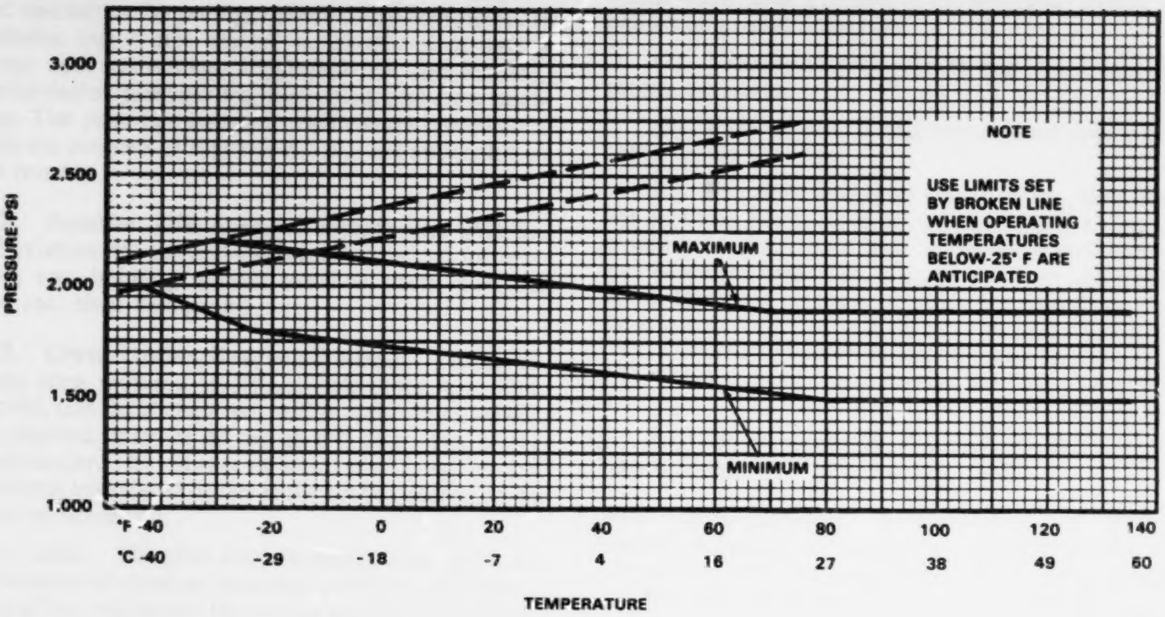


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Figure 7-71. Apu Start Accumulator Precharge Limits

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CHAPTER 8
NORMAL PROCEDURES

SECTION I MISSION PLANNING

8-1. Mission Planning.

Mission planning begins when the mission is assigned and extends to the preflight check of the helicopter. It includes, but is not limited to, checks of operating limits and restrictions, weight/balance and loading, performance, publications, flight plan, and crew briefings. The pilot in command shall ensure compliance with the contents of this manual that are applicable to the mission.

8-2. Aviation Life Support Equipment (ALSE). All aviation life support equipment required for mission, e.g., helmets, gloves, survival vests, survival kits, etc., shall be checked.

8-3. Crew Duties/Responsibilities. The minimum crew required to fly the helicopter is a pilot, copilot, and flight engineer. Additional crewmembers, as required, may be added at the discretion of the commander. The manner in which each crewmember performs his related duties is the responsibility of the pilot in command.

a. Pilot. The pilot in command is responsible for all aspects of mission planning, preflight, and operation of the helicopter. He will assign duties and functions to all other crewmembers as required. Prior to or during preflight, the pilot will brief the crew on the mission, performance data, monitoring of instruments, communications, emergency procedures, and armament procedures.

b. Copilot. The copilot must be familiar with the pilot's duties and the duties of the other crew positions. The copilot will assist the pilot as directed.

c. Flight Engineer. The flight engineer will perform all duties as assigned by the pilot in addition to the following specific duties:

(1) Performs or coordinates maintenance, servicing, inspection, loading, and security of the helicopter.

(2) Checks that log book is current and correct.

(3) Accompanies pilot during preflight inspection; performs the inspection with the pilot.

(4) Checks the security of each area inspected.

(5) Assists in seating and securing passengers; checks load security.

(6) Ensures the helicopter is clear during all starting procedures and informs pilot of any objects which would pose a hazard to the helicopter during all phases of ground operation.

(7) Visually inspects engine and ramp area for proper operation.

(8) Remove chocks and closes ramp door when called for by the pilot.

(9) Observes and gives clearance to pilots during taxi and hover operation. Reports any object or condition which would pose a hazard to the helicopter. When the helicopter is being taxied in obstructed areas, the flight engineer or other crewmembers may be required to act as taxi director or blade watchers. Taxi drivers and blade watchers must be familiar with CH-47 ground turning characteristics. (fig. 2-3 and 8-1.)

(10) Perform check of ramp area and maintenance panel every 30 minutes of flight.

8-4. Crew Briefing. A crew briefing shall be conducted to ensure a thorough understanding of individual and team responsibilities. The briefing should include, but not be limited to, copilot, mission equipment operator, and ground crew responsibilities and the coordination necessary to complete the mission in the most efficient manner. A review of visual signals is desirable when ground guides do not have a direct voice communications link with the crew.

8-5. Passenger Briefing. The following is a guide that should be used in accomplishing required passenger briefings. Items that do not pertain to a specific mission may be omitted.

a. Crew introduction.

b. Equipment.

(1) Personal to include ID tags.

(2) Professional.

(3) Survival.

c. Flight Data.

(1) Route.

(2) Altitude.

(3) Time en route.

(4) Weather.

d. Normal Procedures.

(1) Entry and exit of helicopter.

(2) Seating.

(3) Seat belts.

(4) Movement in helicopter.

(5) Internal communications.

(6) Security of equipment.

(7) Smoking.

(8) Oxygen.

(9) Refueling.

(10) Weapons.

(11) Protective masks.

(12) Parachutes.

(13) Ear protection.

(14) ALSE.

e. Emergency Procedures.

(1) Emergency exits.

(2) Emergency equipment.

(3) Emergency landing/ditching procedures.

SECTION II OPERATING PROCEDURES AND MANEUVERS

8-6. Operating Procedures and Maneuvers.

This section deals with normal procedures and includes all steps necessary to ensure safe and efficient operation of the helicopter from the time a preflight begins until the flight is completed and the helicopter is parked and secured. Unique feel, characteristics, and reaction of the helicopter during various phases of operation and the techniques and procedures used for hovering, takeoff, climb, etc., are described, including precautions to be observed. Your flying experience is recognized; therefore, basic flight principles are avoided. Only the duties of the minimum crew necessary for the actual operation of the helicopter are included.

8-7. Mission Equipment Checks. Mission equipment checks are contained in Chapter 4, MISSION EQUIPMENT. Descriptions of functions, operations, and effects of controls are covered in Section IV, FLIGHT CHARACTERISTICS, and are repeated in this section only when required for emphasis. Checks that must be performed under adverse environmental conditions, such as desert and cold weather operations, supplement normal procedures checks in this section and are covered in Section V, ADVERSE ENVIRONMENTAL CONDITIONS.

8-8. Symbols Definitions. The checklist includes items for day, night, and instrument flight with annotative indicators immediately preceding the check to which they are pertinent: N for night operation only, I for instrument operations only, and 0 to indicate a requirement if the equipment is installed. The symbol ★ indicates that a detailed procedure for the step is located in the performance section of the condensed checklist. When a helicopter is flown on a mission requiring intermediate stops, it is not necessary to perform all of the normal checks. The steps that are essential for safe helicopter operations on intermediate stops are designated as "thru-flight" checks. An asterisk * indicates that performance of steps is mandatory for all "thru-flights" when there has been no change in pilot-in-command. The asterisk applies only to checks performed prior to takeoff. These duties which will be performed by the copilot will be indicated by a circle around the step number; i.e., ④.

8-9. Checklist. Normal procedures are given primarily in checklist form and amplified as necessary in accompanying paragraph form when a detailed description of a procedure or maneuver is required. A condensed version of the amplified checklist, omitting all explanatory text, is contained in the Operators and Crewmembers Checklist, TM 55-1520-240-CL.

8-10. Preflight Check. The pilot's walk-around and interior checks are outlined in the following procedures. The preflight check is not intended to be a detailed mechanical inspection. The steps that are essential for safe helicopter operation are included. The preflight may be made as comprehensive as conditions warrant at the discretion of the pilot.

8-11. Before Exterior Check.

*1. Publications — Check DA Forms 2408-12, -13, -14, -18, DD Form 365F, and DD Form 1896, locally required forms and publications, and availability of operators manual (-10), and checklist (-CL).

*2. Ignition lock switch — On.

3. Emergency power panel — Check trip indicators and timers.

4. Topping stops — Check stowed.

5. Cockpit area — Check as follows:
   a. General condition.
   b. Fire extinguisher.
   c. Jettisonable door release handles/latches.
   d. Sliding windows.

*6. Forward transmission — Check oil level, filter button, and oil cooler condition.

7. Fuel sample — Check before first flight of the day.

8-12. INTERIOR CHECK.

8-13. Forward Cabin.

1. Flight control closet — Check ilca actuators for extended jam buttons. Check installation of soundproofing.
2. Heater compartment — Check security of components and winch.
3. Emergency escape ax — Check condition and security.
4. Cabin door — Check condition and security.
5. Avionics equipment — Check security of components and connections. Determine whether both pilots displacement gyros are installed.
6. Fire extinguisher — Check seal intact and security.
7. Cabin escape panel — Check condition and security.
8. Transformer-rectifier air intake screens — Check both clear. A transformer-rectifier may fail if rags or other items stowed behind the troop seats block the air intakes.

9. Seats, litters, first aid kits, cargo and jettisonable cabin windows — Check condition and security.
10. Utility hatch door and lower rescue door — Check condition and position as required.
11. Center cargo hook — Check condition and position as required. Check 2,100 psi charge, manual release mechanisms stowed, manual release mechanism for proper cam position and latched.
12. Forward and aft cargo hook release lever — Check for security and stowed.

8-14. Aft Cabin.

1. Ramp — Check.
2. Engine fire extinguisher bottles — Check.
3. Power steering accumulator — Check pressure.
4. Engine No. 2 fuel valve — Check open.
5. Right crossfeed fuel valve — Closed.
6. Fill module — Check condition, fluid level, cover secure, and valve closed.

*7. Apu start accumulators — Check pressures. If pressure is less than 3,000 psi, pressurize the system with the hand pump before attempting to start the apu.

*8. Maintenance panel — Check for tripped bite indicators and hydraulic fluid levels.

*9. Aft transmission — Check as follows:
   a. Oil level.
   b. Filter button.
   c. Oil cooler.
   d. Secure doors.

10. Apu — Check.
11. Apu manual fuel shutoff — Check OPEN.
12. Compass flux valve — Check.
13. Left crossfeed fuel valve — Check Closed.
14. Engine No. 1 fuel valve — Check Open.
15. Fire extinguisher — Check.

8-15. EXTERIOR CHECK.

8-16. Aft Cabin.

1. Position light — Check condition.
2. Right aft landing gear area — Check condition and security of all components as follows:
   a. Gear support structure.
   b. Tire.
   c. Shock strut extension and static lock stowed.
   d. Power steering actuator and brakes.
   e. Fluid lines.
   f. Electrical wiring.
   g. Ground proximity switch and linkage.
   h. Swivel lock.
3. Vent and fluid drain lines — Check unobstructed.

8-17. Right Cabin.

1. Fuselage — Check as other items are checked.

*2. Fuel System — Check as required, caps secured.

3. Position light — Check condition.
4. Forward landing gear area — Check condition and security of all components as follows:
   a. Tire.
   b. Shock strut for extension.
   c. Brakes.
   d. Fluid lines.
5. Pressure refueling panel — Check as follows:
   a. PWR and LT switches at OFF.
   b. Refueling receptacle cover installed and secured.
   c. Landing gear and pressure refueling panel cover closed and secure.
6. Static port — Check unobstructed.
7. Right electrical compartment — Check condition and security.

8-18. Forward Cabin.

1. Heater intake, exhaust, and combustor drain — Check.
2. Pilot's jettisonable door — Check.
3. Pilot's pedal area — Check.
4. Right AFCS yaw ports — Check.
5. Pitot tubes — Check.
6. Antennas — Check.
7. Searchlights — Check.
8. Windshield and wipers — Check.
9. Left AFCS yaw port — Check.
10. Copilot's pedal area — Check.
11. Copilot's jettisonable door — Check.

8-19. Left Cabin.

1. Fuselage — Check as other items are checked.
2. Left electrical compartment — Check.
3. Forward landing gear area — Check condition and security of all components as follows:
   a. Tires.
   b. Shock strut for extension.
   c. Brakes.
   d. Fluid lines.

4. Forward and aft cargo hooks — Check hooks clear and load beam closed. Electrical harness and release cable connected and dust caps stowed. If hook not installed, check for dust caps on the electrical and release cable receptacles.
5. Lower anti-collision light — Check condition.
6. Static port — Check unobstructed.

*7. Fuel system — Check as required, caps secure.

8. Left aft landing gear area — Check condition and security of all components as follows:

a. Gear support structure.

b. Tire.

c. Shock strut extension and static lock stowed.

d. Static ground wire contacting the ground.

e. Fluid lines.

f. Electrical wiring.

g. Ground proximity switch and linkage.

h. Brakes.

i. Swivel lock.

9. Fluid vent and drain lines — Check unobstructed.

8-20. Top of Fuselage.

*1. No. 2 engine — Check as follows:

a. Inlet for foreign objects. Check condition and security of FOD screens.

b. Oil level and cap secure.

c. Cowling for security.

d. Tailpipe condition and security, presence of fuel, oil, and foreign objects.

2. Anticollision light and formation lights — Check condition.

*3. Aft rotor (right side) — Check blades for condition and reservoir oil levels.

(0)4. Droop stop shrouds — Check condition and security. Check inspection cover closed.

5. Upper boost actuator — Check for extended jam indicators and exposed piston rods for cleanliness.

★6. Hydraulic compartment — Check as follows:

a. Condition and security of lines and coolers.

b. No. 2 flight control system accumulator for proper indication. (See chart in Chapter 7.)

c. Utility reservoir pressurization accumulator for 2500 to 3500 psi charge.

*7. Combining transmission area — Check for foreign objects, and oil coolers for obstructions. Check filter buttons for engines and combining transmissions.

*8. Aft rotor (left side) — Check blades for condition and reservoir oil levels.

(0)9. Droop stop shrouds — Check condition and security.

10. Upper boost actuator — Check for extended jam indicators and exposed pistons for cleanliness.

*11. No. 1 engine — Check same as No. 2 engine.

12. Drive shaft area — Check condition and security as follows:

a. Drive shafts, couplings, and mounts.

b. Fluid lines.

c. Control linkage.

d. Foreign objects.

e. Drive shaft fairing.

*13. Forward rotor (right side) — Check same as aft rotor.

14. Forward transmission oil cooler inlet — Check for obstructions.

15. Upper boost actuators — Check for extended jam indicators and exposed pistons for cleanliness.

16. Forward transmission — Check for foreign objects and oil cooler condition.

★17. Hydraulic compartment — Check as follows:

a. Condition and security of lines and coolers.

b. No. 1 flight control system accumulator. (See chart in Chapter 7.)

*18. Forward rotor (left side) — Check same as aft rotor.

19. Brake accumulator pressure — Check 600 to 1400 psi.

*20. Pylon fairings, work platforms, and inspection panels — Check secure.

21. Top of fuselage — Check for foreign objects.

*8-21. Walk Around Inspection and Security Brief.

1. All access doors — Check secure.

2. Tie downs, locking devices, covers, and ground cables — Removed and secure.

3. Cockpit, fwd transmission, and fwd cabin area soundproofing installed — Check.

NOTE

The cockpit, forward transmission, flight control, and avionics compartment soundproofing should be installed during normal aircraft operation to reduce noise levels in the crew and passenger areas and to aid in venting of transmission heat and fumes.

4. Crew/passenger briefing — Complete as required.

8-22. Before Starting Engines.

1. Pedal adjustment — Matched. Check that yaw pedals are adjusted equally and that adjustment pins are in the same hole position. Uneven pedal adjustment can cause droop stop pounding during engine start and ground operations.

2. Shoulder harness locks — Check operation and leave unlocked.

*3. No. 1 and No. 2 power distribution panels — Check all circuit breakers in and gang bar up.

*4. Overhead switches and control panels. Set as follows:

  *a. LTG switches — As required.

  *b. LIGHTING switches — As required.

  c. COMPASS switch — As required.

  d. TROOP WARN switches — OFF.

  e. HEATING switches — As required.

  f. WINDSHIELD WIPERS switch — OFF.

  g. ELECT switches — Set as follows:

    (1) BATT switch — OFF.

    (2) APU switch — OFF.

    (3) No. 1 and No. 2 GEN switches — OFF.

    (4) APU GEN switch — OFF.

  *h. FUEL CONTROL switches — Set as follows:

    (1) CROSSFEED FUEL VALVES switch — OPEN.

    (2) Refuel STATION switch — OFF.

    (3) Left main FUEL PUMPS switches — ON.

    (4) All remaining FUEL PUMPS switches — OFF.

  i. START switches — OFF.

  j. ENGINE CONDITION levers — STOP.

  *k. LIGHTING switches — As required.

  l. ANTI-ICE switches — OFF.

  m. HOIST switches — OFF.

  n. CARGO HOOK switches — Set as follows:

    (1) MASTER switch — OFF.

    (2) SELECT switch — As required.

    (3) EMERG REL ALL switch — OFF. Cover down.

  o. HYDRAULIC switches — Set as follows:

    (1) POWER XFR switches — OFF.

    (2) FLT CONTR switch — BOTH.

    (3) BRAKE STEER switch — ON. Cover down.

    (4) RAMP switch — ON.

5. FIRE PULL handles — In.

6. FIRE EXT AGENT switch — Check spring-loaded to the neutral position.

*7. XMSN OIL PRESS switch — SCAN.

*8. XMSN OIL TEMP switch — SCAN.

*9. VGI switches — NORM.

10. CYCLIC TRIM switch — AUTO.

*11. AFCS SYSTEM SEL switch — OFF.

*12. Flare dispenser control switch — SAFE.

13. Avionics equipment — OFF; set as required.

14. EMERG ENG TRIM switches — AUTO; covers down.

15. SWIVEL switch — LOCK.

8-23. Starting Engines.

*①. BATT switch — ON.

2. CAUTION LIGHTS SYSTEM TEST switch — TEST. Check that all caution capsules and the two master caution lights on the instrument panel come on. Some of the caution capsules will be on before the system is checked.

3. Clocks — Running. Set as required.

④. TROOP ALARM and JUMP LIGHTS — Check as required.

*5. Fire guard — Posted.

**⑥. APU — Start as follows:

  a. APU switch — RUN for 3 to 5 seconds.

  b. APU switch — START for 2 seconds, then RUN.

NOTE

If the start is not completed or the APU is automatically shut down, wait one minute for cooling before attempting a restart. Failure to allow the APU to cool may cause a premature shutdown on restart due to overtemperature.

  c. APU ON caution light — Check on in 10 to 12 seconds. If the start is not completed, or the APU is automatically shut down, do not turn the BATT switch OFF. Set the APU switch to OFF, and check the bite indicators on the control unit for the cause of the shutdown. Record this information on DA Form 2408-13. Then turn the BATT switch OFF.

*7. UTIL HYD SYS caution light — Check out. If the light does not go out within 30 seconds after APU ON caution light comes on, APU switch — OFF.

*⑧. APU GEN switch — ON. RECT OFF caution lights out.

*⑨. POWER XFR NO. 1 and POWER XFR NO. 2 switches — ON.

*10. HYD FLT CONTR caution lights — Check out. If either HYD FLT CONTR caution lights do not go out in 30 seconds after the POWER XFR switches are set to ON, set the POWER XFR switch to OFF. Do not fly the helicopter. An entry in DA Form 2408-13 is required.

*11. Maintenance panel — Check.

  a. GND switch — TEST, then RESET (Flight Engineer).

  (0)b. Ground contact lights — Check on (Flight Engineer).

*12. Avionics — On as desired.

★13. CARGO HOOKS HOIST/WINCH — Check operation as required. Refer to Chapter 4, Section III.

14. SLTs — Check and set as desired.

*15. Parking brakes — Set.

16. CRUISE GUIDE indicator — Check for pointer in white test band when the CGI TEST switch is at FWD and AFT.

*17. Altimeters — Set and check as follows:
   a. Barometric altimeter — Set and check.
   b. Radar altimeter — ON and set.

18. FIRE DETECTOR switch — TEST. Check fire warning lights on, release switch, and check fire warning lights out.

*19. Fuel quantity — Check as required.

*20. Cyclic trim indicators — Check GND position.

*21. Rotor blades — Check position. Make sure that a rotor blade is not within 30° of the centerline of the fuselage throughout control check (Flight Engineer).

*22. AFCS SYSTEM SEL switch — Set to 1, then BOTH. Check that both AFCS caution lights go out. Set to 2, then OFF. Check that the opposite AFCS caution light is on when the switch is at 1 or 2.

*23. Flight control travel and hydraulics — Check as follows:
   a. Check each individual flight control hydraulic system. Check each flight control axis individually and in combination with other axes through full travel for smoothness of motion and absence of cross-coupling.

CAUTION

If helicopter is parked on a slope greater than 4°, longitudinal stick travel may be restricted to less than 7 inches forward (up slope) or 4 inches aft (down slope).

   b. Check caution lights as this check is being performed. If the flight controls are moved erratically during the control check, unusual vibrations may be felt.
   c. Check cyclic for freedom of movements in all quadrants. Check for a minimum of 7 inches forward and 4 inches aft travel.
   d. Check thrust and pedals individually through full travel for freedom of movement.
   e. FLT CONTR switch — BOTH.
   f. Position the cyclic and pedals at neutral, thrust at ground detent.

24. Avionics — Perform operational check and set as required.

*25. ENGINE BEEP TRIM switch (NO. 1 & 2) — DECREASE for 8 seconds.

*26. Area — Clear for start.

CAUTION

The flight controls must be manned any time the helicopter is on the ground with rotors turning.

NOTE

Either engine may be started first.

★*㉗. First engine — Start as follows:
   a. Check L and R FUEL PRESS lights out.
   b. ENGINE CONDITION LEVER — STOP.
   c. ENGINE START switch — MOTOR.
   d. ENGINE CONDITION lever — GROUND at 10 to 15 percent N1. START switch to START immediately. Release START switch to MOTOR prior to ptit reaching 450°C. When N1 is 50 percent, set START switch to OFF. Check STARTER ON caution light out.
   e. Engine instruments — Check when stabilized at ground idle (N1 at 60 to 63%). Check engine oil pressure for 20 psi minimum. The engine should accelerate to ground idle speed within 45 seconds.

CAUTION

Start the second engine within 3 minutes after first engine is started.

★*㉘. Second Engine — Start by using the same method as first engine.

*㉙. Transmission oil pressures — Check for minimum of 7 psi. There is no time limit for ground idle operation, provided there is a minimum of 7 psi oil pressure in each transmission.

CAUTION

Failure of either engine to accelerate smoothly from ground to flight may be an indication of a clutch malfunction in the engine transmission (para 9-22).

*㉚. ENGINE CONDITION levers (NO. 1 & 2) — FLIGHT. Engine acceleration should be smooth with no surging.

CAUTION

Failure of either engine N1 and torque to respond to normal or emergency beep trim inputs may be an indication of a clutch malfunction in the engine transmission (para 9-22).

*31. Rotor RPM — Set as required.

*㉜. NO. 1 and NO. 2 GEN switch — ON, GEN OFF caution light out.

*㉝. APU GEN switch — OFF.

*㉞. NO. 1 and NO. 2 POWER XFR switches — OFF.

*㉟. APU switch — OFF, APU ON caution light out.

*36. Systems — Check normal.

*37. Transponder — STBY.

8-24. Engine Ground Operation.

①. Fuel pumps and crossfeed fuel valves — Check operation as follows:

 a. All FUEL PUMPS switches — OFF, L and R FUEL PRESS caution lights should come on.

 b. LEFT SIDE AFT MAIN FUEL PUMPS switch — ON; the L and R FUEL PRESS caution light should go out. Then switch OFF.

 c. Remaining main FUEL PUMPS switches — Check as in step b. above.

 d. LEFT SIDE AFT AUX FUEL PUMPS switch — ON. Check that the left AUX PRESS caution light on overhead panel comes on, then goes out. Set the pump switch to OFF.

 e. Remaining three auxiliary fuel pumps - Check as in step d., except check right AUX PRESS caution light on, then off, for RIGHT SIDE AUX PUMP switches.

*②. FUEL CONTROL switches — Set as follows:

 a. All FUEL PUMPS switches — ON.

 b. CROSSFEED FUEL VALVES switch — CLOSE.

3. VGI switches — As required.

④. ANTI-ICE systems — Check as required.

 a. ENG ANTI-ICE switch — ON. Check for a rise in ptit and a drop in N1. Then switch OFF.

 b. PITOT switch — ON. Physically check for pitot tube and yaw port heat (flight engineer). Then switch OFF.

 c. WINDSHIELDS switches — ON. Physically check for windshield heat. Then switch OFF.

5. Flight instruments — Check as follows:

 a. HSI compass cards — Check synchronized. Crosscheck with magnetic compass.

 b. Attitude indicators — Adjust as required.

*⑥. Emergency engine trim system — Check as follows:

 a. NO. 1 EMERG ENG TRIM switch — DECR momentarily. Check torque and N1 decrease then release. Torque and N1 should return to normal settings.

 b. NO. 2 EMERG ENG TRIM switch — Check same as No. 1 engine.

*7. Radar altimeters — PUSH TO TEST. Check 900 to 1100 feet indication.

*8. Transponder — Check and set.

*8-25. Before Taxi.

CAUTION

To prevent damage to the cargo hooks and structure, do not ground taxi over rough or uneven terrain with the forward and aft cargo hooks installed.

①. SWIVEL switch — As required.

②. AFCS switch — As required.

3. Cyclic trim indicators — Check GND position.

(0)4. Flare dispenser safety pin — Remove and stow. (Flight Engineer)

5. Chocks — Remove and secure. (Flight Engineer)

6. Ramp and cabin door — As required. (Flight Engineer)

7. Crew, passengers, and mission equipment — Check ready for taxi.

8. Taxi director and blade watchers — Positioned as required. (Fig. 8-1.)

9. PARKING BRAKE — As required.

*8-26. Taxiing Check.

1. Brakes — Check pilot's and copilot's as required.

2. Power steering — Check as required.

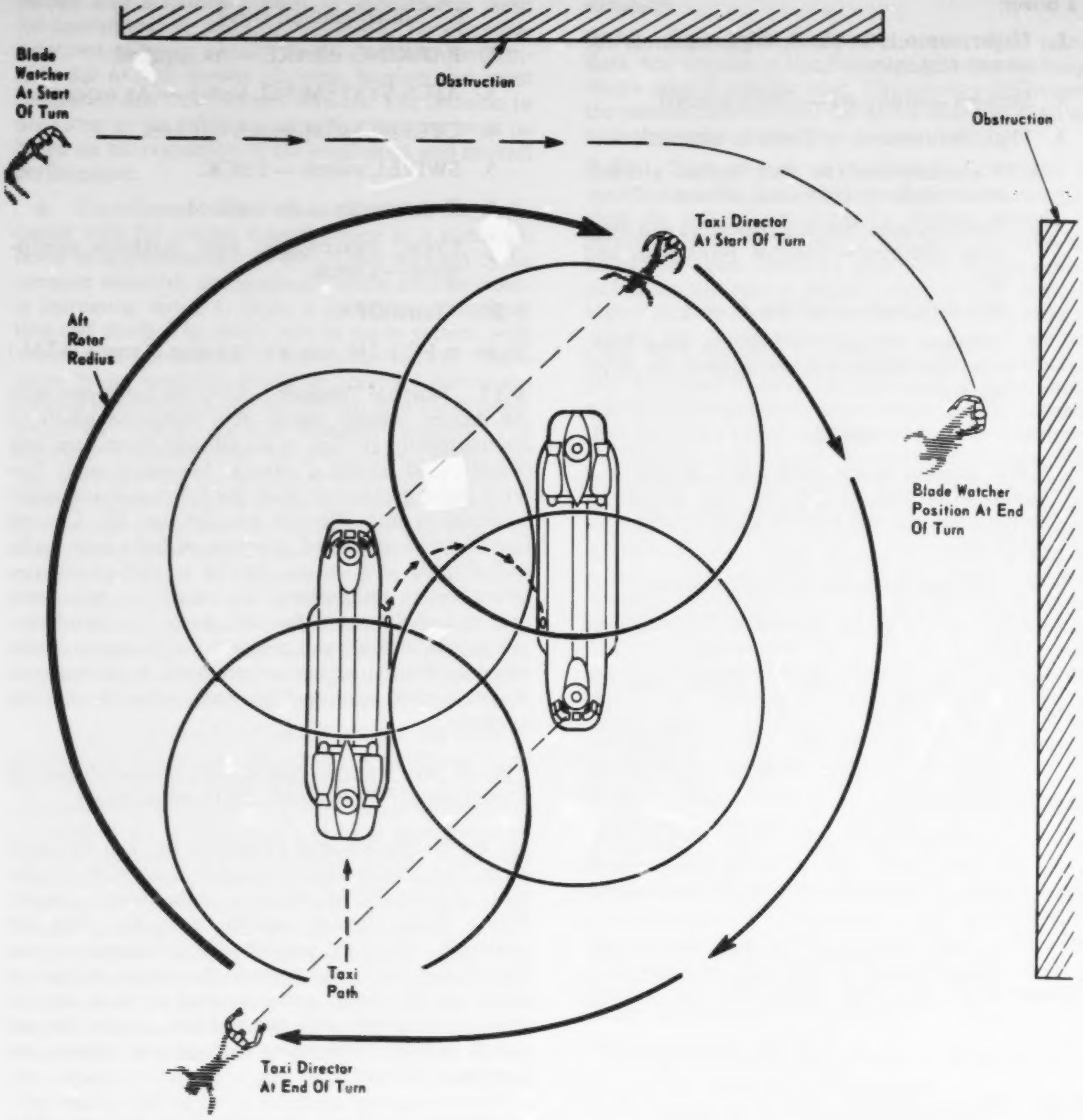
8-27. Before Hover.

*1. SWIVEL switch — LOCK.

*2. AFCS SYSTEM SEL — BOTH.

3. Health Indicator Test (HIT) check — Perform on first flight of the day. The HIT provides the aviator with a check for engine condition prior to takeoff. By logging PTIT deviations from the HIT PTIT baseline, the aviator provides the Maintenance Officer with the information to monitor PTIT trends. This can aid the Maintenance Officer to optimize the maintenance effort and ensure that engines receive attention as soon as performance degradation is noted. Refer to HIT PTIT log in aircraft logbook for procedures.

*4. Rotor RPM — Set as required.


Blade Watcher At Start Of Turn
Obstruction
Obstruction
Taxi Director At Start Of Turn
Aft Rotor Radius
Blade Watcher Position At End Of Turn
Taxi Path
Taxi Director At End Of Turn

NOTES:

1. AVOID TURNING OR MANEUVERING NEAR OBSTRUCTIONS WHEN LESS THAN 75 FEET WILL EXIST BETWEEN CENTERLINE OF THE HELICOPTER AND THE OBSTRUCTIONS.
2. IF NECESSARY TO TAXI WHEN LESS THAN 75 FEET CLEARANCE EXISTS BETWEEN THE CENTERLINE OF THE HELICOPTER AND OBSTRUCTION, USE TAXI DIRECTORS AND BLADE WATCHERS FAMILIAR WITH CH-47 TURNING CHARACTERISTICS.
3. THE BLADE WATCHER SHALL POSITION HIMSELF SO HE HAS A CLEAR VIEW OF THE ROTOR BLADES AND ANY OBSTRUCTIONS, AND THE TAXI DIRECTOR.
4. USE STANDARD HAND SIGNALS. REFER TO TM 55-1500-204-25-1.

D145-70-10

Figure 8-1. Taxi Director and Blade Watcher Positions

8-28. Hover Check. Perform the following check at a hover:

1. Flight controls — Check flight controls for correct response.
2. Systems instruments — Check normal.
3. Flight instruments — Check as required.
   a. VSI, barometric and radar altimeters — indicate climb and descent.
   b. Turn pointers, heading indicators and magnetic compass — Indicate turns right and left.
   c. Slip indicator — Ball free in race.
   d. Attitude indicator — Indicate nose high, nose low, banks left and right — set as required.

NOTE

Rapid rotation of the pitch and roll trim knobs on the attitude indicator may cause abrupt pitch and roll attitude changes with AFCS on.

   e. Airspeed indicator — Check airspeed.
4. AFCS — Check as follows: (First flight of day).
   a. Ground contact lights — Check both off. (Flight engineer).
   b. SYSTEM SEL switch — NO. 1. Check helicopter stable with no abrupt engagement error. Check NO. 2 AFCS OFF caution light ON.
   c. SYSTEM SEL switch — NO. 2. Check helicopter stable with no abrupt engagement error. Check NO. 1 AFCS OFF caution light ON.
   d. SYSTEM SEL switch — Both. Check helicopters stable with no abrupt engagement error. Check both AFCS OFF caution lights out.
5. POWER — Check. Note torque and N1.

***8-29. Before Takeoff.**

1. Systems — Check indications of the following:
   a. Rotor — Check as required.
   b. Torque.
   c. Engine.
   d. Transmission.
   e. Fuel.
   f. Master caution panel.
2. PARKING BRAKE — As required.
3. AFCS SYSTEM SEL switch — As required.
4. CYCLIC TRIM switch — Check.
5. SWIVEL switch — LOCK.
6. Transponder — As required.
7. Crew, passengers, and mission equipment — Check.

8-30. TAKEOFF.

(Refer to FC 1-216 Aircrew Training Manual, ATM.)

8-31. Normal Takeoff. Aline the helicopter with the desired takeoff course at a stabilized hover of approximately 10 feet, or an altitude permitting safe obstacle and terrain clearance. Smoothly apply forward cyclic pressure to level the helicopter and begin acceleration into effective translational lift. Control rate of acceleration and direction of flight with cyclic and altitude with thrust. As the aircraft accelerates thru effective translational lift, establish a pitch attitude and apply thrust that will result in a simultaneous gain in altitude and airspeed. Continuous coordinated application of control pressures is necessary to maintain trim, heading, flight path, airspeed, and rate of climb.

Takeoff over water is begun from a hover height of approximately 30 feet and continued as above.

See the Height-Velocity Diagrams, fig. 9-4, for *avoid* areas. The height-velocity diagram assures the availability of a suitable landing area in the event of engine failure. Since suitable landing areas are often not available, operating outside the *avoid*areas during takeoff and climb will provide the highest margin of safety. Additionally, autorotational landings can be made at minimum sink rate and low or zero forward speed, thereby minimizing damage and injuries, regardless of terrain.

A normal takeoff may be made from the ground by alining the helicopter with the desired takeoff course on the ground and positioning the cyclic control in neutral. Smoothly increase thrust until the helicopter is airborne. As all four gear leave the ground, adjust cyclic pressure and thrust as necessary to begin acceleration. Continue the takeoff as from a hover.

8-32. Maximum Performance Takeoff. A takeoff that demands maximum performance from the aircraft may be necessary because of various combinations of heavy aircraft loads, restricted performance due to high density altitudes, barriers that must be cleared, and other terrain features. The decision to use either of the following takeoff techniques must be based on an evaluation of the conditions and aircraft performance.

a. Coordinated Climb Takeoff. Aline the helicopter with the chosen takeoff course at a stabilized hover of approximately 10 feet. Apply forward cyclic pressure smoothly and gradually while simultaneously increasing thrust to begin a coordinated acceleration and climb. The climb may be made vertical with appropriate adjustment of the cyclic control. Maximum torque available should be applied (without exceeding aircraft limits) as the aircraft attitude is established that will permit safe obstacle clearance. The climbout is continued at that attitude and power setting until the obstacle is cleared. After the obstacle is cleared, adjust aircraft attitude and thrust as required to establish a climb at the desired rate and airspeed. Continuous coordinated application of control pressures is necessary to maintain trim, heading, flight path, airspeed, and rate of climb. Takeoff may be made from the ground by positioning the cyclic control in neutral, prior to increasing thrust. Takeoff over water is begun from a hover height of approximately 30 feet and continued as above.

b. Level Acceleration Takeoff. Aline the helicopter with the chosen takeoff course at a stabilized hover of approximately 10 feet. Apply forward cyclic pressure smoothly and gradually while simultaneously increasing thrust to begin accelerating at approximately 10 feet. Maximum torque available should be applied (without exceeding aircraft limits) prior to accelerating thru effective translational lift. Adjust cyclic stick to maintain desired pitch attitude throughout acceleration to climb airspeed. Approximately 5 knots prior to reaching the selected climb airspeed, gradually release forward cyclic pressure and allow the aircraft to begin a constant airspeed climb to clear the obstacle. Care must be taken not to decrease airspeed during the climbout since this may result in the helicopter descending (*falling thru*). After the obstacle is cleared, adjust aircraft attitude and thrust as required to establish a climb at the desired rate and airspeed. Continuous coordinated application of control pressures is necessary to maintain trim, heading, flight path, airspeed, and rate of climb. Takeoff may be made from the ground by positioning the cyclic control in neutral prior to increasing thrust.

Takeoff over water is begun from a hover height of approximately 30 feet and continued as above.

8-33. Slingload. The slingload is similar to the level acceleration technique except the takeoff is begun and the acceleration made at an altitude that will permit the slingload to clear obstacles. Obstacle heights include the additional height necessary for the slingload.

8-34. Crosswind Takeoff. A crosswind takeoff does not require a significantly different technique than a takeoff into the wind. The primary difference is the requirement to hold the cyclic into the wind and opposite pedal pressure to prevent drift.

8-35. Comparison of Techniques. Where the coordinated climb and level acceleration techniques yield the same distance over a 50-foot obstacle, the coordinated climb technique will give a shorter distance over lower obstacles and the level acceleration technique will give a shorter distance over obstacles higher than 50 feet. The two techniques give approximately the same distance over a 50-foot obstacle when the helicopter can hover just out of ground effect. As hover capability is decreased, the level acceleration technique gives increasingly shorter distances than the coordinated climb technique. In addition to the distance comparison, the main advantages of the level acceleration technique are: (1) It requires less or no time in the *avoid* area of the height velocity diagram; (2) performance is more repeatable since reference to attitudes which change with loading and airspeed is not required; (3) at the higher climbout airspeeds (30 knots or more), reliable indicated airspeeds are available for accurate airspeed reference from the beginning of the climbout therefore, minimizing the possibility of *fall thru*. The main advantage of the coordinated climb technique is that the climb angle is established early in the takeoff and more distance and time are available to abort the takeoff if the obstacle cannot be cleared.

8-36. Climb Refer to chapter 7 for recommended airspeeds, power settings, and fuel flow.

8-37. CRUISE.

When the chosen cruise altitude is reached, adjust power as necessary to maintain required airspeed. Refer to chapter 7 for recommended airspeeds, power settings, and fuel flow. The ramp area must be checked every 30 minutes of flight (flight engineer). (Refer to section I, Crew Duties.)

***8-38. Cruise Check.**

1. Fuel Consumption — Check.
2. Ramp area — Check every 30 minutes. (Flight engineer)

8-39. DESCENT.

Refer to Chapter 7 for power requirements at selected airspeeds and rates of descent.

***8-40. Before Landing.** The following checks must be accomplished prior to landing:

1. Systems — Check indications of the following:
    a. Rotor.
    b. Torque.
    c. Engine.
    d. Transmission.

   e. Fuel.
   f. Master caution panel.
2. PARKING BRAKE — As required.
3. AFCS panel — Check as follows:
   a. AFCS HDG and ALT switches as required.
   b. CYLIC TRIM switch as required.
   c. AFCS selector switch as required.
4. Crew, passengers, and mission equipment — Check.

8-41. LANDING.

Refer to FC1-216, Aircrew Training Manual, (ATM).

8-42. Landing From a Hover to Water. Prior to landing, the PITOT HEAT switch must be ON. The ramp, lower half cabin door, lower rescue door, and drain plugs must be closed. Landing/searchlights shall be retracted. From a stabilized hover, decrease thrust for a smooth rate of descent. A vertical descent, rather than a descent with some forward movement, will tend to disperse the swirling water spray under a no-wind condition. As the aft wheels and then the fuselage near the water, continue to lower the thrust control to ground detent. As more of the fuselage enters the water, buoyancy will level the helicopter attitude.

CAUTION

If contact is made with floating debris, return to hover and assess damage.

As the attitude approaches level, the helicopter will start moving forward and stabilize at approximately 4 to 5 knots. This speed will be attained with the controls in neutral and the thrust control at the ground detent. The water level will not vary significantly because of gross weight or center of gravity. As observed from the cockpit, the water level will appear to intersect the fuselage below the lower nose enclosure.

8-43. Running Landing to Water. Running landings can be performed within the limitations shown in fig. 5-8, but should only be performed during training missions, actual single-engine conditions when a hovering approach is not possible, or when atmospheric conditions dictate. Running landings for training should only be performed to calm water (Sea State 1 or less) by qualified personnel.

Prior to performing a running landing to the water, the PITOT HEAT switch must be ON. The ramp, lower half of cabin door, lower rescue door, and drain plugs must be closed. Landing/searchlights shall be retracted. The approach is shallow, and flown at an airspeed that provides safe aircraft control. Prior to water entry, it may be necessary to use the windshield wipers. Entry of the aft wheels into the water is easily recognized because the helicopter will decelerate noticeably. Touchdown attitude should be held constant until the apparent water speed has decreased below 10 knots. At or below 10 knots, the nose can be lowered to the water by lowering the thrust control rod and neutralizing the cyclic stick. A 4- to 5-knot forward speed will result when the helicopter is level and the controls are neutralized with the thrust control rod at the ground detent.

When the helicopter is in the water, two-way communication is lost on system whose antennas are submerged. The hf radio can be operated.

*8-44. After Landing.

1. AFCS SYSTEM SEL switch — As required.
2. SWIVEL switch — As required.
3. Transponder — As required.
(0)4. Ground contact lights — Check on. (Flight Engineer)
5. Cyclic trim indicators — Check ground indication.

*8-45. Engine Shutdown.

1. Flight Controls — Neutralize. Position the pedals and cyclic at neutral (N on the stick positioner) and the thrust at the ground detent.
2. PARKING BRAKE — Set.
③. HEATING switches — OFF.
④. ANTI-ICE switches — OFF.

CAUTION

If helicopter is parked on a slope greater than 4°, longitudinal stick travel may be restricted to less than 7 inches forward (up slope) or 4 inches aft (down slope).

⑤. Searchlights — OFF and stow as required.
⑥. AFCS SYSTEM SEL switch — OFF.
7. Ramp — As required (Flight Engineer).
8. Wheels — Chocked (Flight Engineer).
9. Mission equipment — Safe.
10. Fire guard — Posted (Flight Engineer).
★⑪. Apu — Start. For apu starting procedures, refer to paragraph 8-23.
⑫. APU GEN switch — ON.
⑬. NO. 1 and NO. 2 GEN switches — OFF.
⑭. POWER XFR switches — ON.
15. Cyclic trim indicators — Check GND position, manually program if necessary.

NOTE

Aft landing gear ground proximity switches are not actuated during a water landing. Therefore, longitudinal cyclic pitch actuators must be manually set to ground position prior to engine shutdown on the water.

★⑯. ENGINE CONDITION levers — GROUND, run engines at GROUND for 2 minutes.

★⑰. FUEL CONTROL switches — Set as follows:

- a. CROSSFEED FUEL VALVES switch — CLOSE.
- b. FUEL PUMPS switches — OFF.
- c. REFUEL STATION switch — As required.

⑱. ENGINE CONDITION levers — STOP.

Monitor temperatures during shutdown. If temperatures rise above 350°C, motor engine immediately until temperature decreases below 260°C. Both engines cannot be motored at the same time

19. Avionics — OFF.
20. Radar altimeters — OFF.
21. Maintenance panel — Check as follows (Flight Engineer).
    - (0)a. Ground contact lights — Check ON.
    - b. Record any BITE indications on DA Form 2408-13.
22. POWER XFR switches — OFF, after rotors have stopped.
23. APU GEN switch — OFF.
24. APU switch — OFF. The apu may be shut down after the rotors have stopped and there is no further need to motor the engines.
25. Light switches — OFF as required.
26. BATT switch — OFF.
27. Ignition lock switch — OFF, key removed as required.
28. Emergency power panel — Check flag indicators for tripped position and log time readings.

8-46. Before Leaving Helicopter.

1. Walk-around inspection — Complete, checking for damage, fluid leaks and levels.
2. Check the following: (Flight Engineer)
    - a. Fluid levels.
    - b. Bypass indicators and filter buttons.
    - c. Jam indicators.
    - d. Cabin and mission equipment secured.
    - e. Tiedowns, grounding cables, and covers.
3. Complete DA Forms 2408-12 and -13. An entry must be made on the -13 any time a water operation was performed.
4. Helicopter — Secure as required.

8-47. Instrument Flight — General. This aircraft is qualified for operation in instrument meteorological conditions. Flight handling, stability characteristics, and range are the same during instrument flight as for visual flight. Navigation and communication equipment are adequate for instrument flight. With both AFCS operating, the helicopter does not exhibit any unusual flight characteristics.

8-48. Instrument Flight Procedures. Refer to FM1-240, FM1-230, FLIP, AR 95-1, FAR Part 91, and procedures described in this manual.

8-49. Night Flying. Refer to FM1-204, Night Flight Techniques and Procedures.

SECTION III FLIGHT CHARACTERISTICS

8-50. GENERAL.

The flight characteristics of the helicopter throughout the flight envelope and at all gross weights are good. The flight characteristics remain essentially the same throughout the center-of-gravity and gross weight range. There is no marked degradation of flying qualities as altitude increases.

8-51. AFCS Off Flight Characteristics. The AFCS is required to provide the helicopter with adequate stability. Therefore, the stability of the helicopter will be reduced when operating with AFCS off. With practice, the pilot will know in advance what to expect and should have little trouble controlling the helicopter as long as established limitations (refer to Chapter 5) and certain techniques are adhered to. In general, the AFCS off flight characteristics are enhanced by spoilers on the forward pylon, strakes on the fuel pods and ramp, and a blunted aft pylon. The AFCS may be turned off at any airspeed and turned back on at any other airspeed including hover. If airspeed at turn-on is different from that at turn-off, a low rate pitch transient accompanied by momentary illumination of the AFCS OFF caution lights may occur. These symptoms indicate that a dash error signal existed at turn-on and that the dash actuator is running at a reduced rate to cancel the error signal. AFCS off flight will not be difficult when the following techniques are used:

a. Maintain airspeed below established limits.

b. Enter all maneuvers smoothly, keep control movements coordinated and avoid overcontrol.

c. Constantly scan the turn-and-slip indicator to maintain trim flight.

d. React positively but smoothly to divergent movements.

NOTE

A low rate pitch transient accompanied by momentary illumination of both AFCS OFF caution lights may occur when the AFCS is turned on following AFCS off flight or ground operation. These symptoms occur when a dash error signal exists, and indicate that the dash actuator is running at a reduced rate to cancel the error signal. When the lights go out, the error signal is cancelled, and normal dash operation has resumed. During this period, when the error signal is being cancelled, the remaining AFCS features function normally.

8-52. CENTER HOOK LOADS.

In general, the helicopter possesses excellent flight characteristics when performing an external load mission. The combination of power available, the load carried beneath the cg, and the design of the cargo hook system make loads of minimum or maximum weight relatively easy to carry and handle safely. The type loads carried can usually be broken down into three major groups: low density, high density, and aerodynamic. Each type load mentioned displays characteristics all its own and therefore must be discussed separately.

CAUTION

External loads must not be rigged entirely with steel cable (wire rope) slings. To dampen vibration tendencies, a nylon vertical riser at least 6 feet long must be placed between the steel cable sling and the nylon loop or metal shackle which attaches to the cargo hook. Nylon and chain leg slings and pure nylon slings must have at least 6 feet of nylon in each leg.

CAUTION

When combination internal and external loads are carried during the same flight and the external load exceeds 12,000 pounds, position the internal load forward of the utility hatch. This procedure will preclude encountering an excessively aft center of gravity.

8-53. Low Density Loads. When carrying low density loads, airspeed is limited by the amount of clearance which can be maintained between the load and the underside of the helicopter since the load will tend to trail aft as speed is increased.

8-54. High Density Loads. High density loads can usually be flown at cruise airspeed and in some cases up to Vne, depending on the configuration of the load, air turbulence, or accompanying vibration.

8-55. Aerodynamic Loads. Aerodynamic loads, such as tow targets, drones, light aircraft, aircraft parts, wings, and tail sections have certain inherent dangers because of their aerodynamic lift capabilities. Therefore, the lift capabilities of external loads must be eliminated before they are lifted. Airspeed and bank angles will be governed by the reaction of the load to the airspeed. Drogue chutes shall also be used to streamline the load. However, the chute must be attached to the load with a swivel fitting.

8-56. Technique. It has been found that no firm limitations can be imposed for low density and aerodynamic loads. Airspeed, bank angles, and the degree of maneuvering must be left to the pilot's judgment. However, the following guidelines will serve to foster good techniques when flying all types of external loads:

a. During initial takeoff with an external load, lift the load smoothly to a height of approximately 10 feet.

b. Controls should be displaced smoothly and cautiously to prevent over-controlling and subsequent oscillation of the load.

c. Airspeed should be slowly increased to determine the characteristics of the load and the speed at which it can be flown.

d. Decreased airspeed and proper flight control displacement should be used to reduce large load oscillations caused by high airspeed or turbulence.

8-57. Multi-Hook Loads. Handling characteristics are improved when loads are slung using two-point (forward and aft hook) sling suspension. Load motion is substantially reduced. Potentially unstable loads are directionally restrained by two-point suspension; airspeed capability is increased above the airspeed for single-point suspension. When low-density high-drag cargo is carried, the risk of single-hook failure in a two-point suspension is reduced by the addition of a safety sling from the center hook to the forward load attachment point. The multi-hook configuration also enables the carrying of three independent loads within the center-of-gravity limits.

SECTION IV ADVERSE ENVIRONMENTAL CONDITIONS

8-58. COLD WEATHER OPERATION.

8-59. General. Operating the helicopter in an environment of extreme low temperature and the associated weather phenomena requires that certain techniques and operating procedures be implemented in addition to the normal operating procedures in section II. The following operating techniques and procedures have been developed from actual arctic flight testing and other pertinent information.

8-60. Preparation for Flight. The following additional exterior checks are to be performed during cold weather operation.

a. Check that all ice, snow, and frost have been removed from the exterior surfaces, particularly the rotor blades.

CAUTION

Ice removal should never be accomplished by chipping or scraping. Deicing fluid should be used.

b. Landing gear shock struts and flight control system actuators should be checked to make certain that exposed shafts are free of dirt, ice, etc.

c. While checking the engines, the compressor should be manually checked for freedom of rotation. Heat must be applied if the compressor is frozen.

d. When operating the ramp, it may be necessary to cycle it once or twice to achieve proper closure.

e. Check that the manually operated vent valves on the rotary-wing shock absorbers are open at temperatures below −18°C. At temperatures between −18°C and −1°C, the vent valves may be open or closed. At temperatures above −1°C, the vent valves must be closed.

f. If seasonal temperatures are +4°C and below, the aft rotor droop stop shrouds should be installed.

g. At temperatures below −18°C, preheating aircraft is recommended for a minimum of 1-1/2 hours. Emphasis should be placed on engine fuel control units.

h. Refer to Chapter 5 for icing limitations.

8-61. Engine Starting. No special cold weather start procedures are required. Refer to Starting Engines (para 8-23).

8-62. Warmup and Ground Tests. Allow the engine and transmission oil pressures and temperatures to stabilize prior to takeoff. This will require several minutes of operation at FLIGHT.

To prevent unnecessary scratches, allow electrical windshield heating to completely soften frost, snow, or ice before using the windshield wipers. Functionally check the engine anti-icing system. (Refer to para 8-23.)

8-63. Taxiing. Difficulty will be encountered when taxiing on ice and snow covered surfaces where braking action is poor. Taxiing on the aft gear (front wheels off the ground) is recommended; however, caution should be taken because of the poor visibility resulting from blowing snow.

8-64. Takeoff. No unusual problems are associated with either the hovering, rolling, or vertical-type takeoffs other than the effects of blowing snow and slippery surfaces. Depending on the weight of snow and ice accumulated on or in the fuselage, takeoff and overall performance can be seriously affected.

8-65. During Flight. Initial hovering with cold hydraulic fluid may produce insensitive control inputs. Hovering above 10 feet (aft wheel clearance) is recommended under these conditions until operation is normal. With AFCS on, light pitch and roll oscillations can be expected during the first 10 or 20 minutes of flight.

8-66. Descent. No unusual problems are encountered during a descent. Use windshield heat if necessary. If bleed band popping occurs during descent, set the engine anti-icing switch to ON.

8-67. Landing in Snow. Landing in loose snow from a hover presents the unusual problem of low visibility caused by blowing snow. This helicopter does not produce this effect to any greater extent than other helicopters; however, caution should be exercised during this type landing.

8-68. After Landing. Maneuvering the helicopter into a slippery parking area may be difficult to accomplish and towing may be necessary. Taxiing on the aft gear should not be used to position the helicopter among other parked aircraft.

8-69. Engine Shutdown. No unusual problems are encountered during engine shutdown as long as the procedures in section II are adhered to.

8-70. Before Leaving Helicopter. If the helicopter is to be parked outside for extended periods, maintenance personnel should install all protective covers and secure the rotor blades. When ambient temperatures of −18°C and below are expected and the helicopter is to be parked outside, maintenance personnel should also remove the battery and store it in a warm area until required for further operation.

8-71. DESERT AND HOT WEATHER OPERATION.

8-72. General. The reduction in power available and the resulting decrease in helicopter performance caused by reduced air density is the main consideration during desert and hot weather operation. Therefore, greater emphasis must be placed on determining performance during mission planning.

8-73. Preparation for Flight. A normal preflight inspection is to be conducted as described in section II. Extra emphasis should be placed on equipment which may be affected by higher temperatures, such as tires, seals, and hydraulic components. In addition, check equipment for signs of deterioration or excessive abrasion from blowing dust or sand. Windows and doors should be opened to provide increased ventilation.

8-74. Engine Starting. The normal engine starting procedures in section II are to be used.

8-75. Taxiing. Braking should be kept to a minimum to prevent overheating. Ground operation in general should be kept to a minimum.

8-76. Takeoff, Climb, Cruise, and Descent. Helicopter performance may be reduced; therefore, techniques should be adjusted accordingly.

8-77. Landing. The landing procedures in section II apply. Braking should be kept to a minimum to prevent overheating.

8-78. Engine Shutdown. It may be necessary to motor the engines if temperature does not decrease below 350°C. It may not be possible to lower the temperature to 260°C. If the temperature will not decrease below 260°C, terminate motoring when the temperature indication stabilizes.

8-79. Before Leaving the Aircraft. Leave all windows and doors open to increase ventilation, except during conditions of blowing dust or sand.

8-80. TURBULENCE AND THUNDERSTORM OPERATION.

8-81. Flight in Turbulent Air. Flying in areas where turbulence is forecast should be avoided. However, when forced to enter such an area, the following procedures are recommended.

8-82. Prior to Entering Turbulent Air.

CAUTION

To prevent engine overtorque, do not enter forecast moderate or stronger turbulence with an inoperative cockpit controlled drive actuator or with BARO ALT engaged.

Prior to entering moderate or stronger turbulent air, the following should be accomplished:

1. BARO ALT switch — Disengaged.
2. Crew — Alert.
3. Airspeed — Adjust as follows:
   a. In severe turbulence, decrease airspeed to Vne minus 15 knots or to maximum range, whichever is slower. (Refer to chapter 7.)
   b. In moderate turbulence, decrease airspeed to Vne minus 10 knots or to maximum range, whichever is slower. (Refer to chapter 7.)
4. Longitudinal cyclic trim — Select MAN, then adjust both actuators for the airspeed to be flown. This is accomplished to prevent the cyclic trim actuators from cycling.
5. Loose equipment — Secure.
6. Safety belts and shoulder harnesses — Tighten.
7. Attitude indicators — Set for level flight.

8-83. In Turbulent Air. The thrust control position, when adjusted for the airspeeds mentioned above, should be maintained and the attitude indicator should be used as the primary pitch instrument. The altimeter and vertical velocity indicator may vary excessively in turbulence and should not be relied upon. Airspeed may vary as much as 40 knots. By maintaining a constant thrust control rod position and a level flight attitude on the attitude indicator, airspeed will remain relatively constant even when erroneous readings are presented by the airspeed indicator.

8-84. Flight in Thunderstorms. Flight in or in close proximity to thunderstorms is to be avoided because of the accompanying severe turbulence and restricted visibility. If a thunderstorm is inadvertently encountered during flight, the procedures for flight in turbulent air are to be followed and the flight path altered to leave the area. Should a thunderstorm be encountered during a night flight, the cockpit dome light should be turned on with white light selected to minimize the blinding effect of lightning. Refer to chapter 5 for limitations.

8-85. ICE AND RAIN.

8-86. Ice. The helicopter is equipped with adequate engine anti-icing, pitot tube and AFCS yaw port heating, and windshield anti-icing systems to enable safe flight in light icing conditions. Operation of these systems is described in Chapter 2. Additional information and specific procedures are also included in this section under Cold Weather Operations. The greatest damage caused by ice accumulation is lowered rotor blade efficiency resulting in decreased range and endurance.

If icing is encountered during IMC flight, consideration must be given to reduced range and endurance due to increased fuel consumption. Refer to chapter 5 for limitations.

8-87. Exterior Inspection. Refer to paragraph 8-15.

8-88. Taxiing. Taxi at slow speeds to ensure positive braking action during turns. The forward tilt of the rotors will cause the helicopter to continue moving forward if icy conditions prevent braking.

8-89. Before Takeoff. When the takeoff is to be accomplished into possible icing conditions, the following are to be accomplished as part of the Before Takeoff Check.

1. ANTI-ICE switches — ON. Refer to chapter 5 for limitations.

8-90. During Flight. Since all of the systems on this helicopter are of the anti-icing rather than the deicing type, always start systems at least 5 minutes before entering a suspect or forecast icing area. In addition, engine icing can occur at temperatures above freezing. Engine anti-icing should be used in accordance with limitations in chapter 5.

a. Extended flight in light icing conditions may result in lateral and vertical vibrations caused by asymmetric self-shedding of ice. Minor rotor blade damage may occur from ice shedding at −10°C and below. One-per-rev lateral vibrations from asymmetric shedding at any temperature may occur. If vibrations are encountered, airspeed should be reduced and the aircraft should be flown out of the icing area.

b. Extended flight in icing conditions can result in ice accumulating on the aircraft heater fuel drain. If the heater shuts down during icing, do not attempt restart until ice is removed from the helicopter.

8-91. Approach and Landing. Accomplish a normal approach and landing; but if icing is present, increased power will be required. The forward and aft wheels accumulate ice which can result in the brakes freezing. If icing conditions have been encountered, a zero forward ground speed landing should be accomplished.

8-92. Rain. It is considered that rain will have no detrimental effect on the flight characteristics or performance of the helicopter. The windshield wipers should be adjusted to FAST during an instrument approach in rain, as rain may present a restriction to visibility. Pitot heat should be used for flights in rain to prevent moisture from accumulating in the pitot tube and afcs yaw ports and tubing.

8-93. SALT WATER OPERATION.

8-94. Power Deterioration. Salt spray ingestion in turbine engines may result in a loss in performance as well as a loss in compressor stall margin. This reduction in stall margin makes the engine susceptible to stalls during acceleration, and, more particularly, under deceleration conditions. As spray is ingested and strikes the compressor blades and stator vanes, salt is deposited. The resulting buildup gradually changes the airfoil sections, which in turn affects performance. This deterioration will be noticed as a decrease in torque and an increase in ptit for a given N1. Should the deterioration reach the point where the compressor actually stalls, ptit will increase, while N1 and torque will decrease. The circumstances under which power deterioration may occur during salt water operation vary with a number of factors. The flight regime, gross weight, wind direction and velocity, pilot technique, duration of maneuver, salinity of the water, and the relative density of the salt spray, all have a bearing on performance deterioration. Intermittent operation in moderate salt spray conditions could expose the engines to enough salt spray to cause noticeable performance deterioration. During prolonged operations (such as low hovering) in heavier spray conditions, power deterioration will be apparent and is more critical. Maneuvers such as hovering close to the water in light winds, or low flights at low speeds will generate maximum rotor downwash spray conditions. Careful operation, following the procedures and limitations contained herein, in strict adherence to the prescribed maintenance procedures when operating in these conditions, should result in the preservation of rated engine power.

8-95. Hovering. Hovering over salt water at altitudes which causes concentrated spray into the engine inlets results in gradual power deterioration and eventual reduction of compressor stall margin. Operation in these conditions should be avoided or minimized. The following procedures are grouped according to wind conditions. Maximum hovering altitude, consistent with safety and mission accomplishment, is recommended to reduce possibility of salt spray ingestion. Prolonged hovering over salt water which results in spray ingestion, indicated by spray on the windshield, must be avoided. The amount of spray observed on the windshield is usually the best indication of spray ingestion into the engine inlets.

a. No wind. Hovering in a no-wind condition normally results in a relatively low spray concentration at all hovering altitudes.

b. Light winds (approximately 5 to 16 knots). Hovering in these conditions results in the heaviest or most critical spray concentrations. Spray can be minimized by heading changes with reference to wind direction and ascertaining minimum spray concentration on windshield.

c. *Moderate to heavy winds (15 knots and above).* Higher winds normally result in the lowest of spray concentration at all hovering altitudes. In these conditions, hovering can be accomplished into the wind.

8-96. After Flight. Following salt water operation, entries should be made in DA Form 2408-13 so that appropriate maintenance action can be taken.

If icing is encountered during IMC flight, consideration must be given to reduced range and endurance due to increased fuel consumption. Refer to chapter 5 for limitations.

8-102. Exterior Inspection. Refer to paragraph 8-16.

8-103. Taxiing. Taxi at slow speeds to ensure positive braking action during turns. The forward tilt of the rotors will cause the helicopter to continue moving forward if icy conditions prevent braking.

8-104. Before Takeoff. When the takeoff is to be accomplished into possible icing conditions, the following are to be accomplished as part of the Before Takeoff Check.

1. ANTI-ICE switches — ON. Refer to chapter 5 for limitations.

8-105. During Flight.

a. Since all of the systems on this helicopter are of the anti-icing rather than the de-icing type, always start systems at least 5 minutes before entering a suspect or forecast icing area. In addition, engine icing can occur at temperatures above freezing. Engine anti-icing should be used in accordance with limitations in chapter 5.

b. Extended flight in light icing conditions may result in lateral and vertical vibrations caused by asymmetric self-shedding of ice. Minor rotor blade damage may occur from ice shedding at −10°C and below. One-per-rev lateral vibrations from asymetric shedding at any temperature may occur. If vibrations are encountered, airspeed should be reduced and the aircraft should be flown out of the icing area.

c. Extended flight in icing conditions can result in ice accumulating on the aircraft heater fuel drain. If the heater shuts down during icing, do not attempt restart until ice is removed from the helicopter

8-106. Approach and Landing. Accomplish a normal approach and landing; but if icing is present, increased power will be required. The forward and aft wheels accumulate ice which can result in the brakes freezing. If icing conditions have been encountered, a zero forward ground speed landing should be accomplished.

8-107. Rain.

It is considered that rain will have no detrimental effect on the flight characteristics or performance of the helicopter. The windshield wipers should be adjusted to FAST during an instrument approach in rain, as rain may present a restriction to visibility. Pitot heat should be used for flights in rain to prevent moisture from accumulating in the pitot tube and afcs yaw ports and tubing.

8-108. Salt Water Operation.

8-109. Power Deterioration.

Salt spray ingestion in turbine engines may result in a loss in performance as well as a loss in compressor stall margin. This reduction in stall margin makes the engine susceptible to stalls during acceleration, and, more particularly, under deceleration conditions. As spray is ingested and strikes the compressor blades and stator vanes, salt is deposited. The resulting buildup gradually changes the airfoil sections, which in turn affects performance. This deterioration will be noticed as a decrease in torque and an increase in ptit for a given N1. Should the deterioration reach the point where the compressor actually stalls, ptit will increase, while N1 and torque will decrease. The circumstances under which power deterioration may occur during salt water operation vary with a number of factors. The flight regime, gross weight, wind direction and velocity, pilot technique, duration of maneuver, salinity of the water, and the relative density of the salt spray, all have a bearing on performance deterioration. Intermittent operation in moderate salt spray conditions could expose the engines to enough salt spray to cause noticeable performance deterioration. During prolonged operations (such as low hovering) in heavier spray conditions, power deterioration will be apparent and is more critical. Maneuvers such as hovering close to the water in light winds, or low flights at low speeds will generate maximum rotor downwash spray conditions. Careful operation, following the procedures and limitations contained herein, in strict adherence to the prescribed maintenance procedures when operating in these conditions, should result in the preservation of rated engine power.

8-110. Hovering.

Hovering over salt water at altitudes which causes concentrated spray into the engine inlets results in gradual power deterioration and eventual reduction of compressor stall margin. Operation in these conditions should be avoided or minimized. The following procedures are grouped according to wind conditions. Maximum hovering altitude, consistent with safety and mission accomplishment, is recommended to reduce possibility of salt spray ingestion. Prolonged hovering over salt water which results in spray ingestion, indicated by spray on the windshield, must be avoided. The amount of spray observed on the windshield is usually the best indication of spray ingestion into the engine inlets.

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b. Light winds (approximately 5 to 16 knots). Hovering in these conditions results in the heaviest or most critical spray concentrations. Spray can be minimized by heading changes with reference to wind direction and ascertaining minimum spray concentration on windshield.

c. Moderate to heavy winds (15 knots and above). Higher winds normally result in the lowest of spray concentration at all hovering altitudes. In these conditions, hovering can be accomplished into the wind.

8-111. Following salt water operation, appropriate entries should be made in DA Form 2408-13, reflecting altitudes, power losses, etc.

SECTION V CREW DUTIES

8-112. Responsibilities.

The minimum crew required to fly the helicopter is a pilot, a copilot, and a flight engineer. Additional crewmembers, as required, may be added at the discretion of the commander. The manner in which each crewmember performs his related duties is the responsibility of the pilot in command.

8-113. Pilot.

The pilot in command is responsible for all aspects of mission planning, preflight, and operation of the helicopter. He will assign duties and functions to all other crewmembers as required. Prior to or during preflight, the pilot will brief the crew on the mission, performance data, monitoring of instruments, communications, emergency procedures, taxi, and load operations.

8-114. Copilot.

The copilot will assist the pilot as directed.

8-115. Flight Engineer.

The flight engineer will perform all duties as assigned by the pilot, in addition to the following specific duties:

a. Performs or coordinates maintenance, servicing, inspection, loading, and security of the helicopter.

b. Checks that log book is current and correct.

c. Accompanies pilot during preflight inspection; performs the inspection with the pilot.

d. Checks the security of each area inspected.

e. Assists in seating and securing passengers; checks load security.

f. Ensures the helicopter is clear during all starting procedures and informs pilot of any objects which would pose a hazard to the helicopter during all phases of ground operation.

g. Visually inspects engine and ramp area for proper operation.

h. Remove chocks and closes ramp door when called for by the pilot.

i. Observes and gives clearance to pilots during taxi and hover operation. Reports any object or condition which would pose a hazard to the helicopter. When the helicopter is being taxied in obstructed areas, the flight engineer or other crewmembers may be required to act as taxi director or blade watchers. Taxi directors and blade watchers must be familiar with CH-47 ground turning characteristics. (See fig. 2-3 and 8-4.)

j. Perform check of ramp area and maintenance panel every 30 minutes of flight.

★*8-116. Passenger Briefing.*

The following is a guide that should be used in accomplishing required passenger briefings, when a unit passenger briefing is not available. Items that do not pertain to a specific mission may be omitted.

a. Crew introduction.

b. Equipment.
  (1) Personal to include ID tags.
  (2) Professional.
  (3) Survival.

c. Flight Data.
  (1) Route.
  (2) Altitude.
  (3) Time en route.
  (4) Weather.

d. Normal Procedures.
  (1) Entry and exit of helicopter.
  (2) Seating.
  (3) Seat belts.
  (4) Movement in helicopter.
  (5) Internal communications.
  (6) Security of equipment.
  (7) Smoking.
  (8) Oxygen.
  (9) Refueling.
  (10) Weapons.
  (11) Protective masks.
  (12) Parachutes.

e. Emergency Procedures.
  (1) Emergency exits.
  (2) Emergency equipment.
  (3) Emergency landing/ditching procedures.
  (4) Bailout.

CHAPTER 9

EMERGENCY PROCEDURES

INDEX

Section **Subject** **Page**

I HELICOPTER SYSTEMS

9-1. Helicopter Systems 9-1
9-2. Immediate Action Emergency Checks 9-1
9-4. Emergency Warning Signals 9-1
9-5. After-Emergency Action 9-4
9-6. Engine 9-4
9-7. Flight Characteristics 9-4
9-8. Minimum Rate of Descent—Power Off 9-4
9-9. Maximum Glide Distance—Power Off 9-4
9-10. Failure of Two Engines—Low Altitude/Low Airspeed 9-4
9-11. Failure of Two Engines—Takeoff 9-10
9-12. Failure of Two Engines—Cruise 9-10
9-13. Failure of One Engine 9-10
9-14. Failure of One Engine—Low Altitude/Low Airspeed 9-10
9-15. Failure of One Engine—Takeoff 9-12
9-16. Failure of One Engine—Cruise 9-12
9-17. Abort Start 9-12
9-18. Engine Restart During Flight 9-12
9-19. Engine Cleanup Procedure 9-12
9-20. Normal Engine Beep Trim System Failure (High Side) or N2 Governor Failure 9-12
9-21. Normal Engine Beep Trim System Failure Low Side or Static) 9-13
9-22. Engine Transmission Clutch Failure To Engage 9-13
9-23. Engine Shutdown—Complete Electrical Failure 9-13
9-24. Engine Shutdown—Condition Lever Failure 9-13
9-25. Engine Shutdown With Apu Inoperative 9-13
9-26. Engine Oil—Low Quantity/High Temperature/High or Low Pressure 9-13
9-27. Engine Chip Detector Caution Light ON 9-13
9-28. Torque Measuring System Malfunctions 9-14
9-29. Rotor, Transmission, and Drive Systems 9-14
9-30. Transmission Low Oil Pressure or High Temperature Indications 9-14
9-31. XMSN OIL PRESS Caution Light On 9-14
9-32. XMSN OIL PRESS and XMSN AUX OIL PRESS Caution Lights On 9-14
9-33. XMSN OIL HOT Caution Light On 9-14
9-34. NO. 1 or NO. 2 ENG XMSN HOT Caution Light On 9-14
9-35. XMSN AUX OIL PRESS Caution Light On 9-14
9-36. XMSN CHIP DET Caution Light On 9-15
9-37. Rotor Blades or Drive Failure 9-15
9-38. Rotor Tachometer Failure 9-15
9-39. Ground Resonance 9-15
9-40. Blade Stall 9-15
9-41. Fire 9-15
9-42. Engine Fire 9-15
9-43. Engine Residual Fire During Starting and Shutdown 9-15
9-44. Auxiliary Power Unit (Apu) Fire 9-15
9-45. Engine Fire—Flight 9-15
9-46. Engine Fire—Ground 9-15
9-47. Fuselage Fire—Ground 9-16
9-48. Fuselage Fire—Flight 9-16
9-49. Electrical Fire 9-16
9-50. Electrical Fire—Flight 9-16
9-51. Electrical Fire—Flight Continued 9-16
9-52. Electrical Fire—Ground 9-16
9-53. Smoke and Fume Elimination 9-16
9-54. Fuel System
9-55. Aux Fuel Pump Failure 9-16

INDEX (Continued)

Section Subject Page
9-56. Fuel Venting 9-16
9-57. Fuel Pump System Failure 9-17
9-58. Fuel Low Caution Light On 9-17
9-59. Electrical System 9-17
9-60. Failure of One Generator 9-17
9-61. Failure of Both Generators 9-17
9-62. Single Transformer Rectifier Failure 9-18
9-63. NO. 1 and NO. 2 RECT OFF Caution Lights On 9-18
9-64. BATT SYS MAL Caution Light On 9-18
9-65. Hydraulic System 9-18
9-66. NO. 1 or NO. 2 HYD FLT CONTR Caution Light On 9-18
9-67. NO. 1 and NO. 2 HYD FLT CONTR Caution Lights On 9-18
9-68. UTIL HYD SYS Caution Light ON. 9-18
9-69. Landing and Ditching 9-19
9-70. Emergency Descent 9-19
9-71. Autorotative Landing 9-19
9-72. Landing With Flat Tires 9-19
9-73. Landing With One Engine Inoperative 9-19
9-74. Emergency Entrance 9-19
9-75. Ditching 9-20
9-76. Ditching—Power ON 9-20
9-77. Ditching—Power OFF 9-20
9-78. Duties After Ditching 9-21
9-79. Flight Controls 9-21
9-80. Longitudinal Cyclic Trim System Failure 9-21
9-81. Single AFCS Failure—Both ON 9-22
9-82. Dual AFCS Failure 9-22
9-83. (Deleted.)
9-84. Vertical Gyro Malfunction 9-22
9-85. Differential Airspeed Hold Failure 9-22
9-86. Altitude Hold Failure 9-22
9-87. Heading Select Failure 9-22
9-88. Cockpit—Control Driver Actuator Failure 9-22
9-89. Bailout—Crew/Passengers 9-22
9-90. Armament 9-23

II MISSION EQUIPMENT

9-91. Armament Subsystems—M-24 and M41 9-23
9-92. Misfire 9-23
9-93. Runaway 9-23
9-94. Cargo 9-23
9-95. Jettisoning Internal Cargo 9-23
9-96. Jettisoning External Cargo 9-23
9-97. Cargo Hooks 9-23
9-98. Hoist 9-23

CHAPTER 9

EMERGENCY PROCEDURES

SECTION I HELICOPTER SYSTEMS

9-1. Helicopter Systems.

This section describes helicopter systems emergencies which may reasonably be expected to occur and presents the procedures to be followed. Emergency procedures are given in checklist form when applicable. A condensed version of these procedures is included in Operators and Crewmembers Checklist TM 55-1520-240-CL. Emergency procedures involving mission equipment are covered in section II, Mission Equipment, and are repeated in this section only insofar as they affect safety of flight. Emergency operation of avionics equipment is covered in chapter 3, Avionics. See fig. 9-1 and 9-2 for emergency equipment, exits, and entrance.

9-2. Immediate Action Emergency Checks.

Actions that must be performed immediately in an emergency procedure are underlined. These immediate action emergency checks shall be memorized.

NOTE

The urgency of certain emergencies requires immediate and instinctive action by the pilot. The most important single consideration is aircraft control. All other procedures are subordinate to this requirement.

9-3. Definition of Terms.

The term LAND AS SOON AS POSSIBLE is defined as executing a landing at the nearest suitable landing area without delay. The primary consideration is to assure the survival of occupants.

The term LAND AS SOON AS PRACTICABLE is defined as executing a landing at the nearest suitable airfield/heliport.

9-4. Emergency Warning Signals.

Since the helicopter is equipped with an emergency troop alarm and jump light system (chapter 2), the following standard signals will be used to notify occupants of an emergency situation:

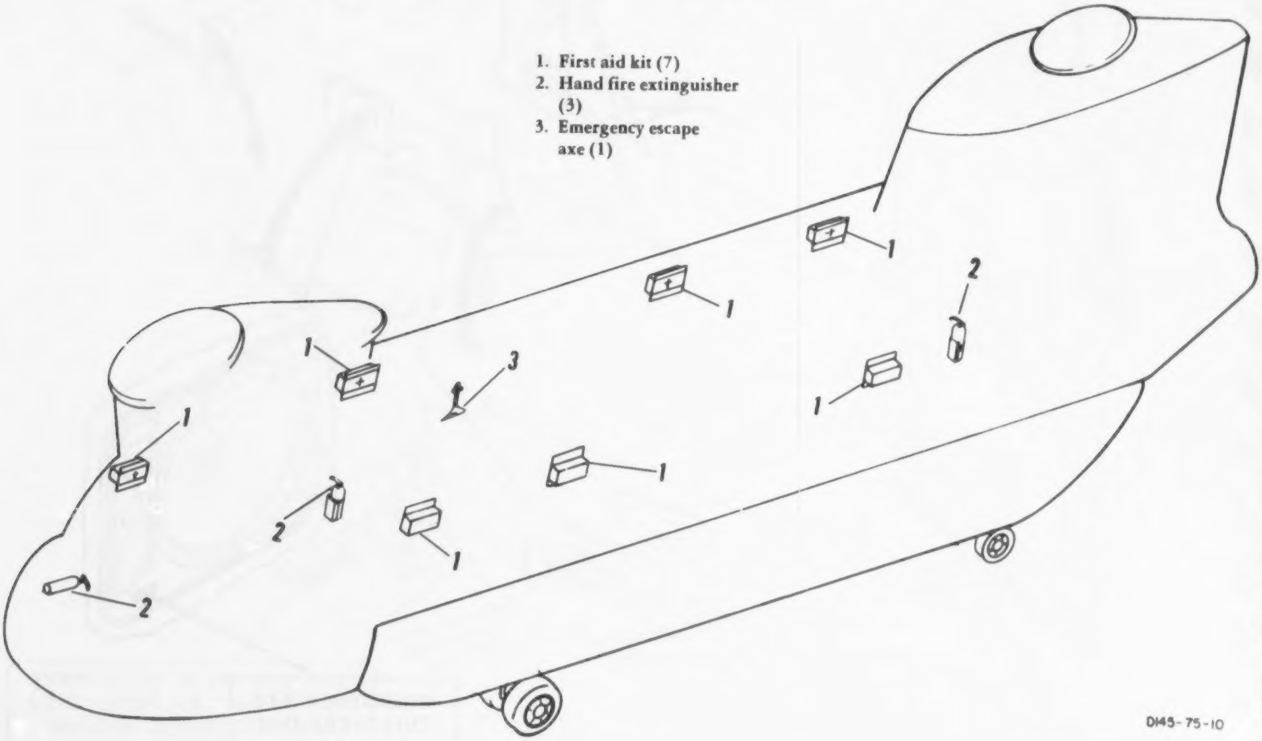

1. First aid kit (7)
2. Hand fire extinguisher (3)
3. Emergency escape axe (1)

Figure 9-1. Emergency Equipment

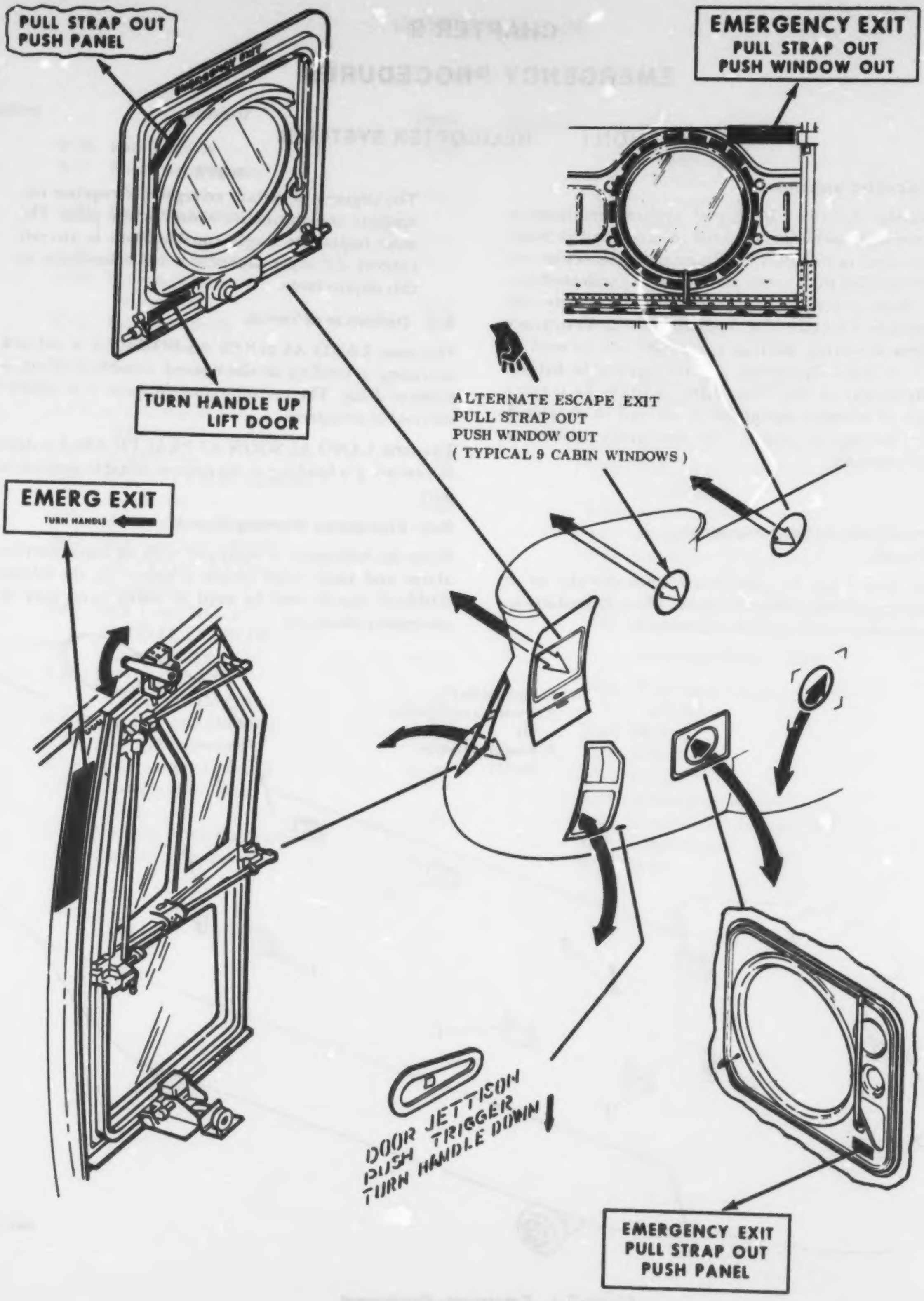
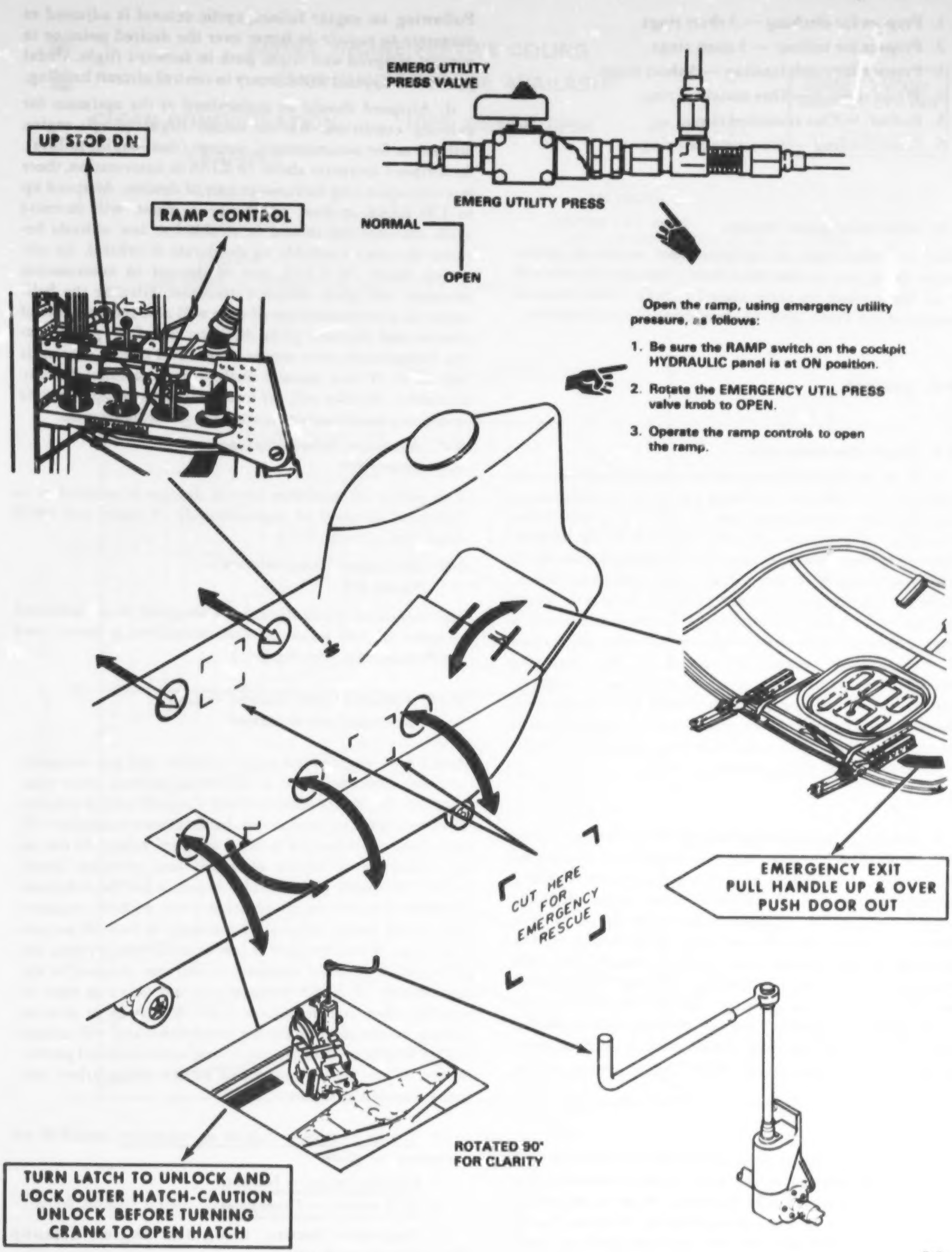

PULL STRAP OUT
PUSH PANEL
EMERGENCY EXIT
EMERGENCY EXIT
PULL STRAP OUT
PUSH WINDOW OUT
TURN HANDLE UP
LIFT DOOR
ALTERNATE ESCAPE EXIT
PULL STRAP OUT
PUSH WINDOW OUT
(TYPICAL 9 CABIN WINDOWS)
EMERG EXIT
TURN HANDLE
DOOR JETTISON
PUSH TRIGGER
TURN HANDLE DOWN
EMERGENCY EXIT
PULL STRAP OUT
PUSH PANEL
816

Figure 9-2. Emergency Entrance and Escape Routes (Sheet 1 of 2)


EMERG UTILITY PRESS VALVE
UP STOP DN
RAMP CONTROL
EMERG UTILITY PRESS
NORMAL
OPEN
CUT HERE FOR EMERGENCY RESCUE
EMERGENCY EXIT PULL HANDLE UP & OVER PUSH DOOR OUT
ROTATED 90° FOR CLARITY
TURN LATCH TO UNLOCK AND LOCK OUTER HATCH-CAUTION UNLOCK BEFORE TURNING CRANK TO OPEN HATCH
817

Open the ramp, using emergency utility pressure, as follows:

1. **Be sure the RAMP switch on the cockpit HYDRAULIC panel is at ON position.**
2. **Rotate the EMERGENCY UTIL PRESS valve knob to OPEN.**
3. **Operate the ramp controls to open the ramp.**

Figure 9-2. Emergency Entrance and Escape Routes (Sheet 2 of 2)

1. Prepare for ditching — 3 short rings.
2. Prepare for bailout — 3 short rings.
3. Prepare for crash landing — 3 short rings.
4. Water contact — One sustained ring.
5. Bailout — One sustained ring.
6. Crash landing — One sustained ring.

9-5. After-Emergency Action.

After a malfunction of equipment has occurred, appropriate emergency actions have been taken, and the aircraft is on the ground, an entry must be made in the Remarks Section of DA Form 2408-13, describing the malfunction.

9-6. ENGINE.

9-7. Flight Characteristics.

a. If an engine failure occurs, no control problems exist unless power from the remaining engine is not sufficient to maintain the selected rotor rpm. If sufficient power is not available to maintain altitude, descend to an altitude where single-engine flight can be accomplished. (See fig. 9-3 for single-engine service ceiling, using emergency power. Refer to paragraph 7-37 for airspeed at which single engine service ceiling is obtained.) The best indication of engine failure is decreased torque on the failed engine and a compensating increase in torque on the remaining engine, accompanied by a droop in rotor rpm. A supporting indication of engine failure may be a continuing decrease in N1 speed. An engine failure will have no effect on any of the helicopter systems as long as the rotor rpm is maintained above the minimum speed.

b. When one engine fails, rotor speed can be expected to drop to as low as 93%. Safe rotor rpm can usually be regained by using engine beep trim and power available of the operating engine. If sufficient power is not available, normal rotor rpm is regained by lowering the thrust control. Procedures to be followed after engine failure will be governed by the altitude and airspeed available for helicopter control and for maintaining sufficient rotor rpm for continued flight and landing. The height-velocity diagram, figure 9-4, presents the airspeeds and wheel heights from which a safe landing can be made at various gross weights and temperatures following a single engine failure.

c. Decrease in thrust after engine failure will vary with altitude and airspeed at the time of the occurrence. For example, thrust must not be decreased when an engine (or engines) fail at a hover in-ground-effect; whereas, during cruise flight conditions, altitude and airspeed are sufficient for a significant reduction in thrust, thereby allowing rotor speed to be maintained in the safe operating range. Following an engine failure, cyclic control is adjusted as necessary to remain in hover over the desired point or to control airspeed and flight path in forward flight. Pedal pressure is applied as necessary to control aircraft heading.

d. Airspeed should be maintained at the optimum for existing conditions for continued flight (single-engine failure) or for autorotational descent (dual-engine failure). As airspeed increases above 70 KIAS in autorotation, there is a corresponding increase in rate of descent. Airspeed up to 100 KIAS or Vne, whichever is lower, will increase glide distance but should be avoided at low altitude because the time available to decelerate is critical. At airspeeds below 70 KIAS, rate of descent in autorotation increases and glide distance decreases. Gliding the helicopter in autorotation out-of-trim will also increase rate of descent and decrease glide distance; therefore, pedal control immediately after engine failure and during descent is important. If time permits during autorotational descent, transmit a *Mayday* call, set transponder to the appropriate emergency mode and code, and lock shoulder harness.

9-8. Minimum Rate of Descent — Power Off.

The power off minimum rate of descent is attained at an indicated airspeed of approximately 70 knots and 100% rotor rpm. (See fig. 9-5.)

9-9. Maximum Glide Distance — Power Off.

The maximum glide distance is attained at an indicated airspeed of 100 knots or Vne, whichever is lower, and 100% rotor rpm. (See fig. 9-5.)

9-10. Failure of Two Engines — Low Altitude/Low Airspeed.

Should both engines fail at low altitude and low airspeed, sufficient altitude is not available to increase rotor rpm. Establish the best autorotational airspeed and decelerate effectively prior to touchdown. Initial thrust reduction will vary from no reduction at zero airspeed below 20 feet to full reduction at higher airspeeds and altitudes. Intermediate airspeeds and altitudes require a partial reduction in thrust to reach the termination point without excessive rotor speed decay. Attempt to maintain at least 96 percent rotor rpm. When airspeed is low and altitude permits, apply forward cyclic as necessary to increase airspeed to approximately 70 KIAS. Jettison external cargo as soon as possible after engine failure. This will help to prevent damage to the aircraft during touchdown and will reduce weight and drag, thereby improving autorotational performance. When both engines fail at low altitude/low airspeed, proceed as follows:

1. Thrust control — Adjust as necessary; establish autorotational glide.
2. External cargo — Jettison.
3. ALT switch — Disengage.
4. Engines — Secure, using the Engine Cleanup Procedure (para 9-19).
5. BATT switch — OFF, after landing.

SINGLE ENGINE SERVICE CEILING
EMERGENCY TORQUE AVAILABLE

SINGLE ENGINE SERVICE CEILING
CH-47D
(1) T55-L-712

CLEAN CONFIGURATION **100% ROTOR RPM** **JP-4 FUEL**

EXAMPLE

WANTED

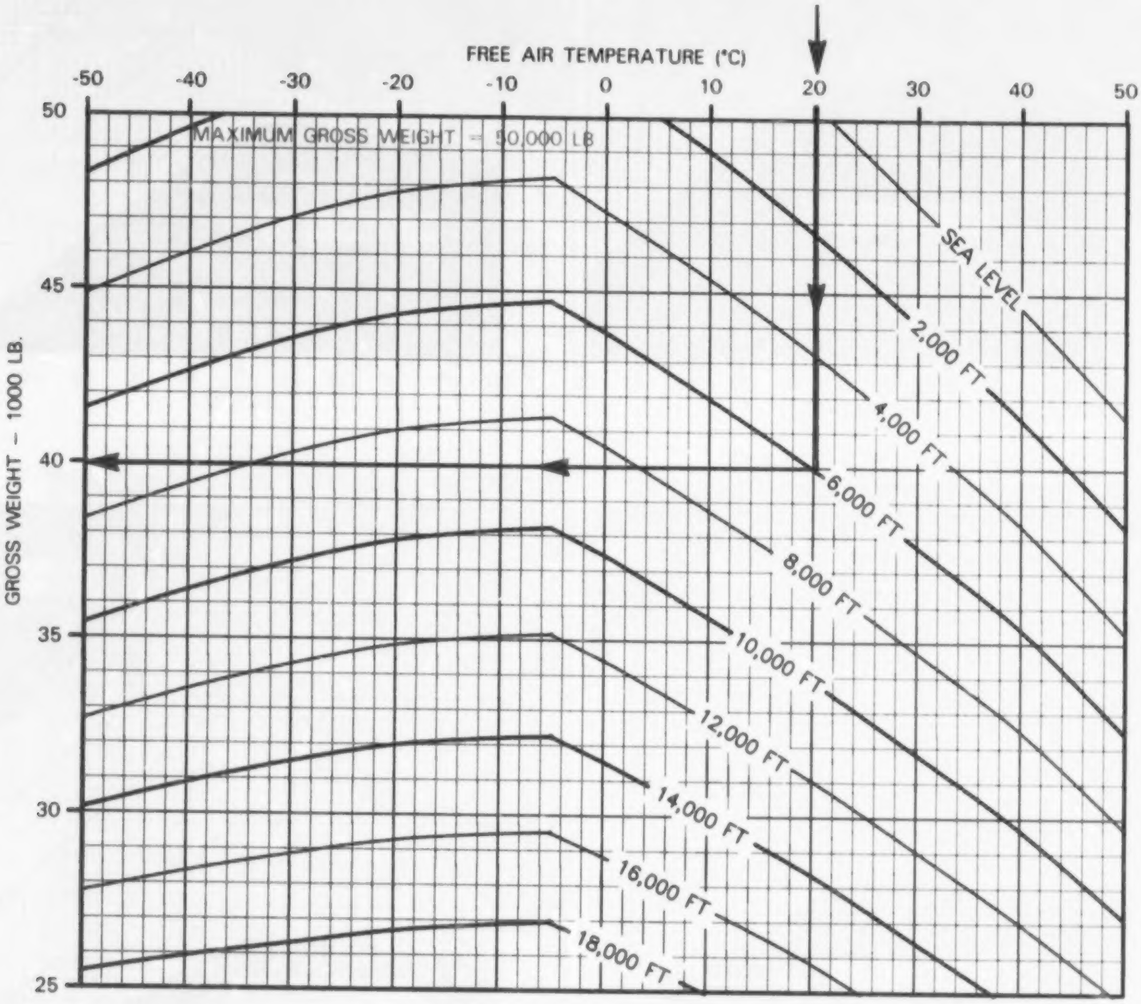
MAXIMUM SINGLE ENGINE WEIGHT AT DESIRED SERVICE CEILING

KNOWN

PRESSURE ALTITUDE = 6,000 FT/FAT = 20°C

METHOD

ENTER FAT HERE
MOVE DOWN TO PRESSURE ALTITUDE
MOVE LEFT AND READ MAXIMUM
SINGLE ENGINE GROSS WEIGHT
=39,990 LB



DATA BASIS: FLIGHT TEST

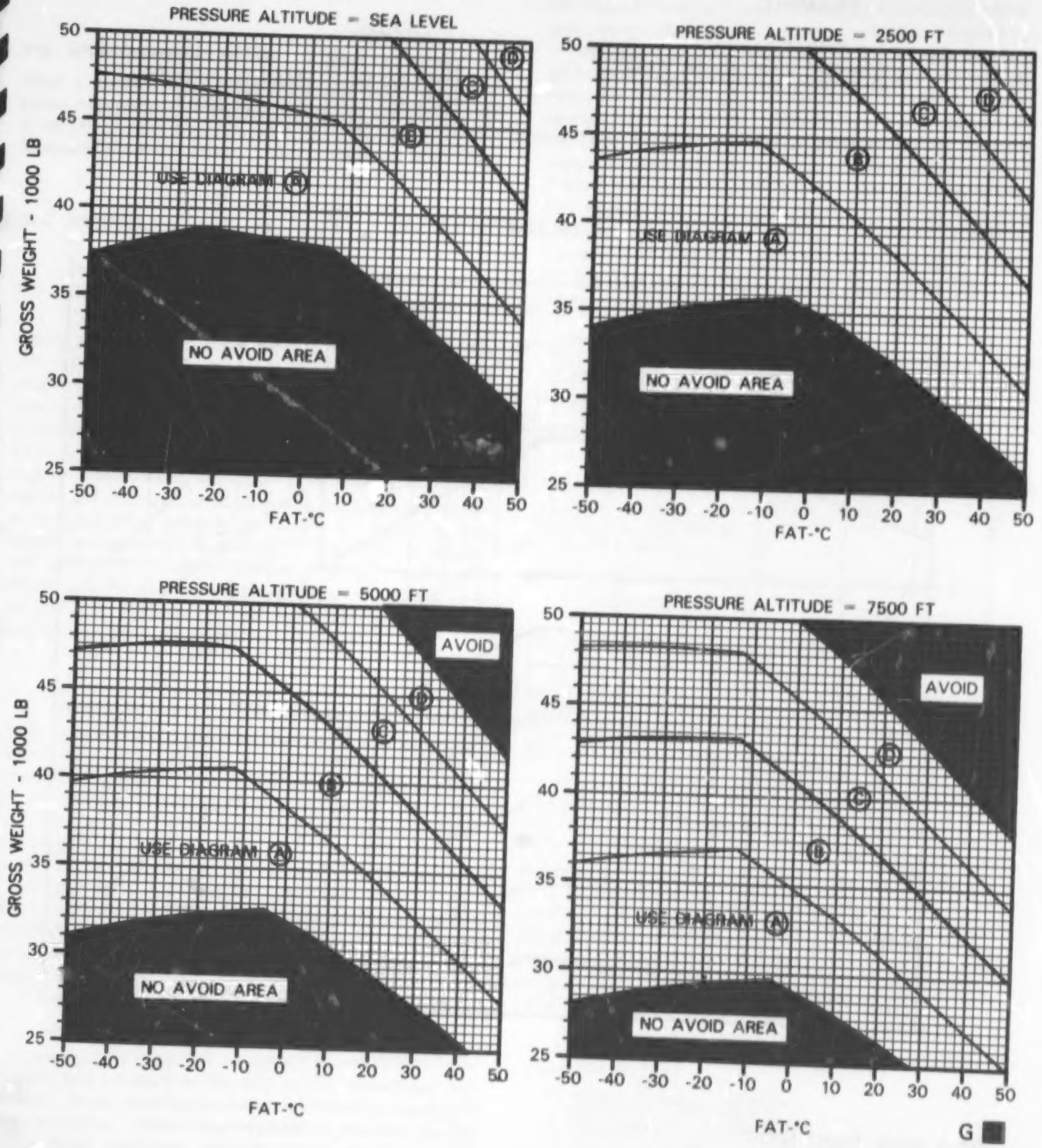
Figure 9-3. Single-Engine Service Ceiling

■ G
■ R

HEIGHT VELOCITY DIAGRAM FOR SAFE LANDING AFTER SINGLE-ENGINE FAILURE

HEIGHT VELOCITY
CH-47D
(2) T55-L-712

NOTE: USE THE FOLLOWING DIAGRAMS WITH THOSE SHOWN ON SHEET 3



G ■
R ■
A9955

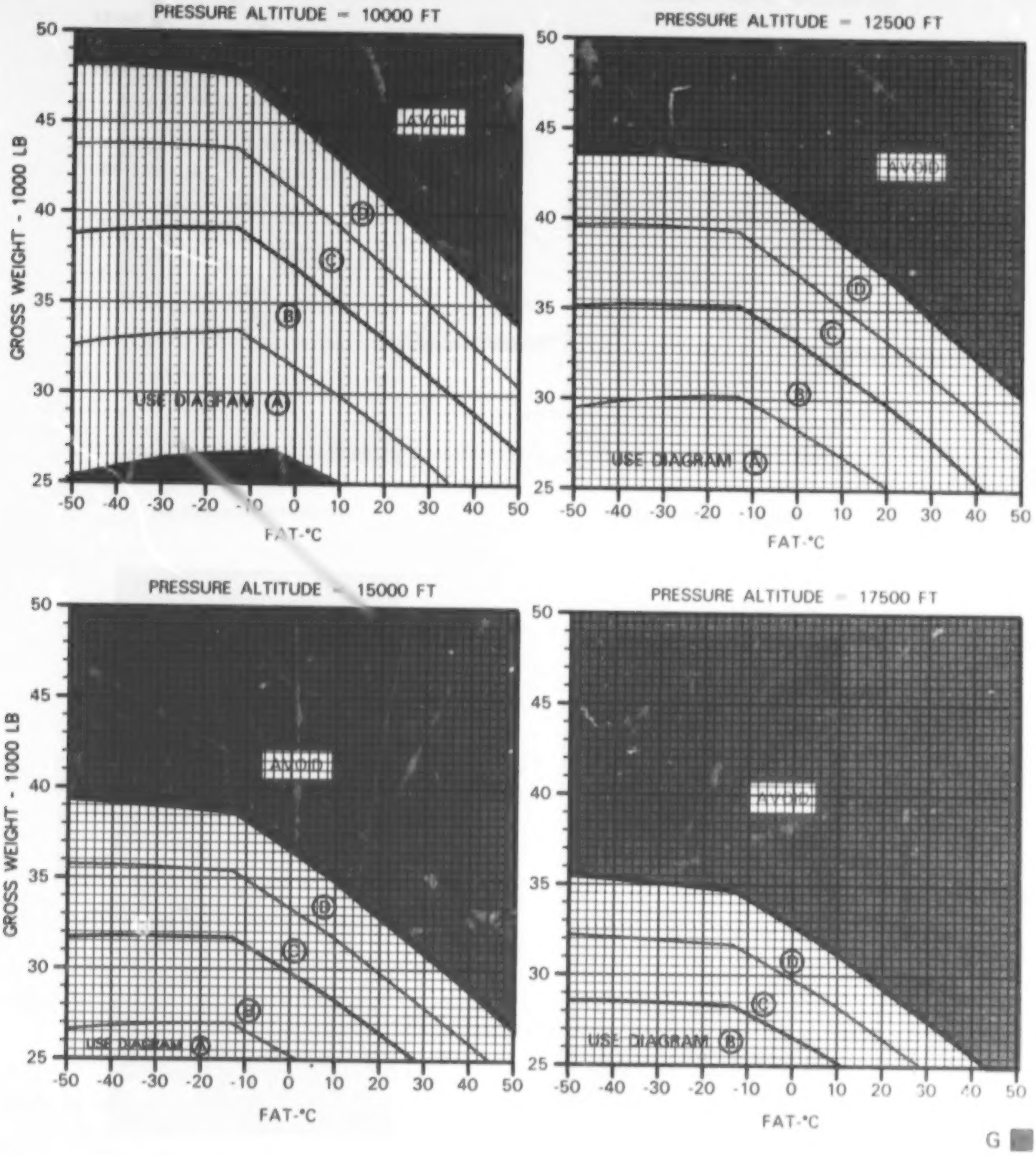
Figure 9-4. Height Velocity Diagram for Safe Landing After Single-Engine Failure (Sheet 1 of 3)

G ■
R ■

HEIGHT VELOCITY DIAGRAM FOR SAFE LANDING AFTER SINGLE-ENGINE FAILURE

HEIGHT VELOCITY
CH-47D
(2) T55-L-712

NOTE: USE THE FOLLOWING DIAGRAMS WITH THOSE SHOWN ON SHEET 3



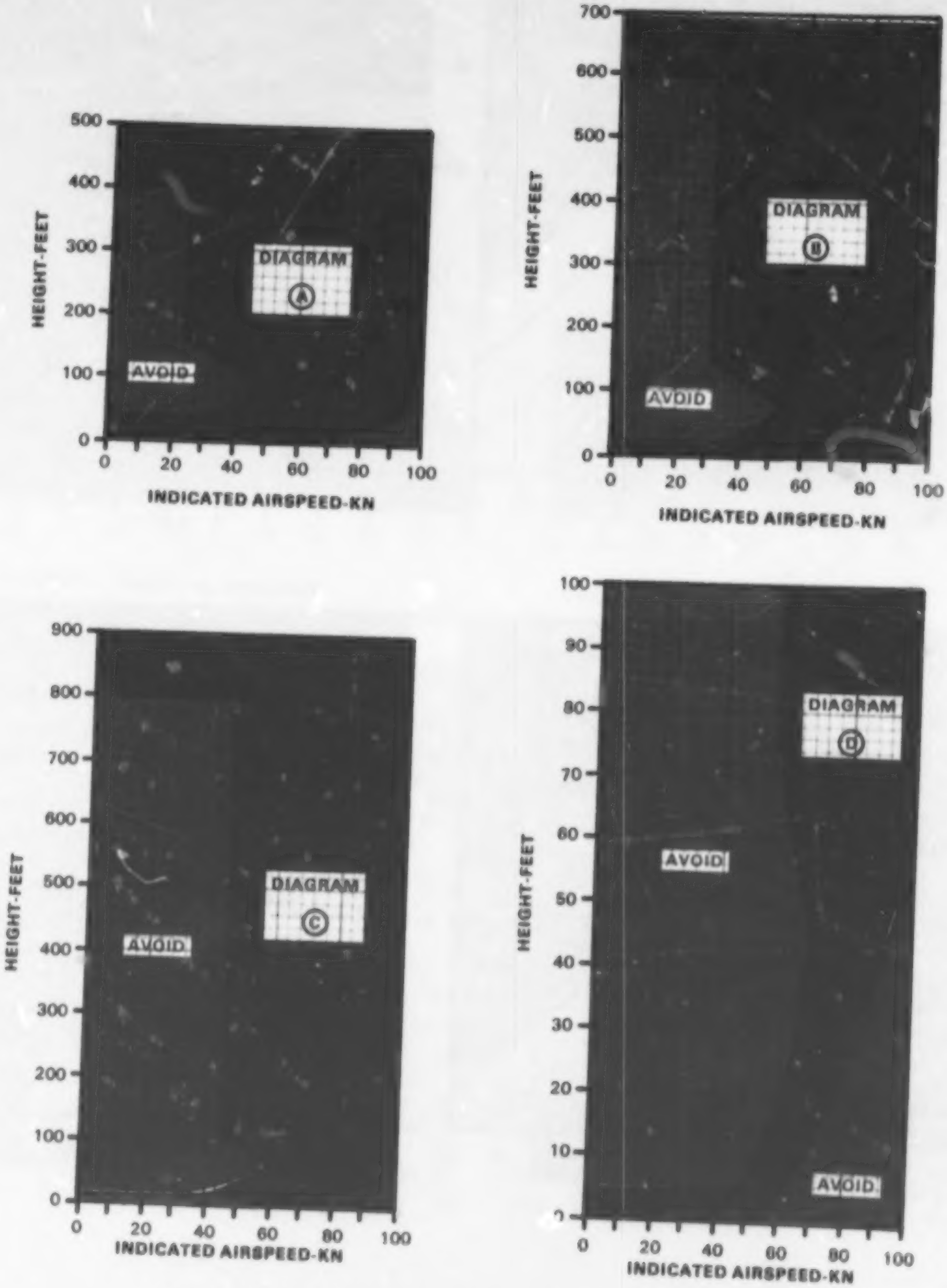
G ■
R □

A10076

Figure 9-4. Height Velocity Diagram for Safe Landing After Single-Engine Failure (Sheet 2 of 3)

HEIGHT VELOCITY DIAGRAM FOR SAFE LANDING AFTER SINGLE ENGINE FAILURE

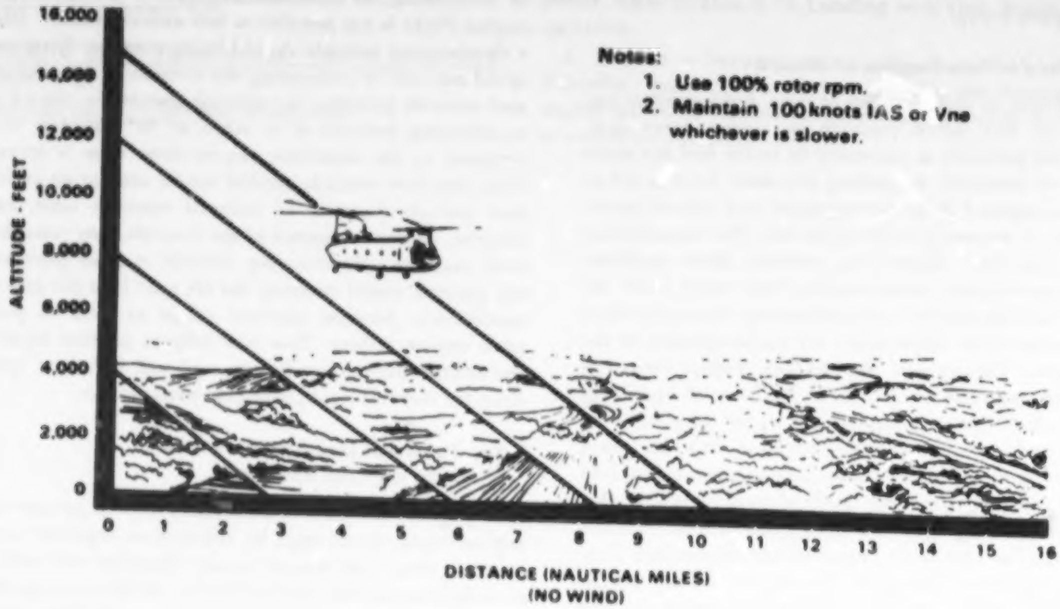
HEIGHT VELOCITY
CH-47D
(2) T55-L-712



G
R

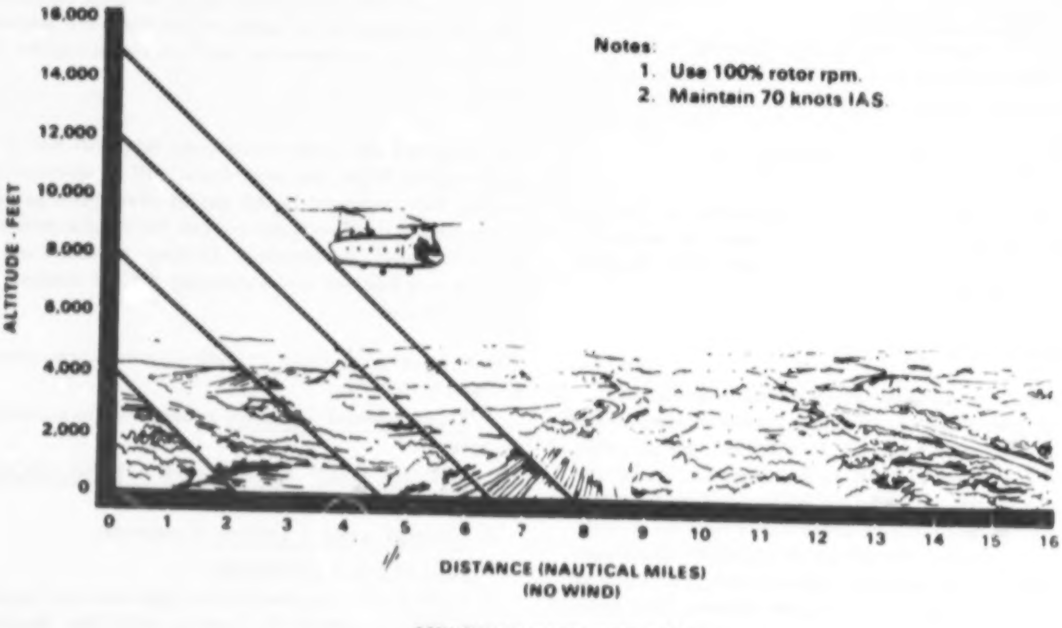
Figure 9-4. Height Velocity Diagram for Safe Landing After Single-Engine Failure (Sheet 3 of 3)

D146-276-10



Notes:
1. Use 100% rotor rpm.
2. Maintain 100 knots IAS or Vne whichever is slower.

MAXIMUM GLIDE DISTANCE



Notes:
1. Use 100% rotor rpm.
2. Maintain 70 knots IAS.

MINIMUM RATE OF DESCENT

D145-72-10

Figure 9-5. Maximum Glide Distance/Minimum Rate of Descent in Autorotation

9-11. Failure of Two Engines — Takeoff.

Refer to Failure of Two Engines — Low Altitude/Low Airspeed (para 9-10).

9-12. Failure of Two Engines — Cruise.

In cruise flight at airspeeds up to Vne, reduce thrust immediately to full down position to regain rotor rpm. Adjust cyclic pressure as necessary to attain and maintain the required airspeed. A landing site must be selected as soon as the engine failure is recognized and control movements made as necessary to fly to the site. The Autorotation Approach Corridor, figure 9-6, presents those combinations of airspeeds and wheel heights from which a safe autorotative landing may be made following a second engine failure. Autorotative approaches are recommended in the caution area. Throughout the descent, adjust thrust as necessary to maintain rotor rpm in the normal operating range. At high gross weights, the rotor may tend to overspeed and may require thrust application to maintain rpm below the upper limit. Thrust should never be applied to reduce rpm for extending glide distance because this reduces rpm available for use during touchdown. Jettison external cargo as soon after engine failure as possible. This will help to prevent damage to the aircraft during touchdown and will reduce weight and drag, thereby improving autorotational performance. When both engines fail at cruise, proceed as follows:

1. Thrust control — Down: establish autorotational glide.
2. External cargo — Jettison.
3. ALT switch — Disengage.
4. Engines — Secure, using the Engine Cleanup Procedure (para 9-19). If time permits during descent, the engines should be secured (Engine Cleanup) to reduce the possibility of fire.
5. BATT switch — OFF, after landing.

If time permits and there are no indications of fire or mechanical malfunctions, an attempt may be made to restart the engines in flight. Refer to para 9-18, Engine Restart During Flight.

9-13. Failure of One Engine.

The action taken after one engine fails will depend on altitude, airspeed, phase of flight, areas available for landing, and single-engine capability of the aircraft. Flight will be discontinued if the aircraft lacks the capability to continue flight on single engine or when terrain and environmental conditions dictate a landing. The failed engine should be checked for the possibility of fire. Thrust control adjustments will depend on altitude at the time of the engine failure. For example, at a hover below 20 feet, maintain thrust control position as the operative engine beep trim is increased. At a hover above 20 feet, thrust should be lowered slightly to maintain at least 96 percent rotor rpm. If altitude permits, thrust may be lowered sufficiently to maintain normal rotor rpm. Cyclic inputs will depend on altitude and airspeed. At an in-ground-effect hover, the aircraft should be maintained in a hovering to level attitude. When continued single-engine flight is not possible at low altitude (below 50 feet), a decelerating attitude should be assumed to dissipate airspeed and aid in cushioning the aircraft. If airspeed is low and altitude permits, the aircraft should be placed in an accelerating attitude of as much as 30° nose-low to gain airspeed as the operative engine beep trim is increased. This nose-low attitude should not be used at an extremely low altitude because of reduced reaction time, rate of descent, and the response of the aircraft. Any time the aircraft assumes a decelerating attitude in close proximity to the ground, avoid rotating the aft gear into the ground at touchdown. Jettison external cargo as soon as possible after engine failure. This will help to prevent damage to the aircraft during touchdown and will reduce weight and drag for improved single-engine performance.

9-14. Failure of One Engine — Low Altitude/Low Airspeed.

If an engine fails under conditions that will permit single-engine flight, thrust must be adjusted as required to maintain safe rotor rpm. Initial thrust reduction will vary from no reduction at zero airspeed below 20 feet to a significant reduction at higher altitudes and airspeeds. The operative engine beep trim must be increased immediately and simultaneously with thrust adjustment. Attempt to maintain at least 97 percent rotor rpm. If the aircraft is below the best single-engine climb airspeed, forward cyclic must be applied to attain that speed. When hovering out of ground effect, forward cyclic pressure must be applied to attain a nose-low attitude of as much as 30° to gain airspeed. As airspeed increases to 30 knots, adjust the pitch attitude of the aircraft to accelerate to the best single-engine climb speed.

If an engine fails under conditions that will *not* permit single-engine flight, the procedures will be essentially the same as for continued flight, except that cyclic pressures are applied to decelerate the aircraft for touchdown, rather than continued acceleration. During deceleration, just prior to touchdown, avoid rotating the aft landing gear into the ground.

When an engine fails at low altitude/low airspeed, proceed as follows:

1. Thrust control — Adjust as necessary to maintain rotor rpm.
2. ENGINE BEEP TRIM switch — RPM INCREASE as required.
3. External cargo — Jettison as required.
4. ALT switch — Disengage.
5. Land as soon as practicable. Approach and land with power. Refer to para 9-73, Landing with One Engine Inoperative.
6. Engine — Secure, using the Engine Cleanup Procedure (para 9-19). If time permits, the inoperative engine should be secured (Engine Cleanup) while in flight to reduce the possibility of fire.

When an engine fails at low altitude/low airspeed, proceed as follows:

1. Thrust control — Adjust as necessary to maintain rotor rpm.
2. ENGINE BEEP TRIM switch — RPM INCREASE as required.
3. External cargo — Jettison as required.
4. ALT switch — Disengage.
5. Land as soon as practicable. Approach and land with power. Refer to para 9-73, Landing with One Engine Inoperative.
6. Engine — Secure, using the Engine Cleanup Procedure (para 9-19). If time permits, the inoperative engine should be secured (Engine Cleanup) while in flight to reduce the possibility of fire.

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AUTOROTATIONAL APPROACH CORRIDOR FOR SECOND ENGINE FAILURE FROM SINGLE ENGINE LEVEL FLIGHT

**AUTOROTATIONAL
APPROACH CORRIDOR
AFTER SECOND ENGINE
FAILURE
CH-47D
(2) T55-L-712**

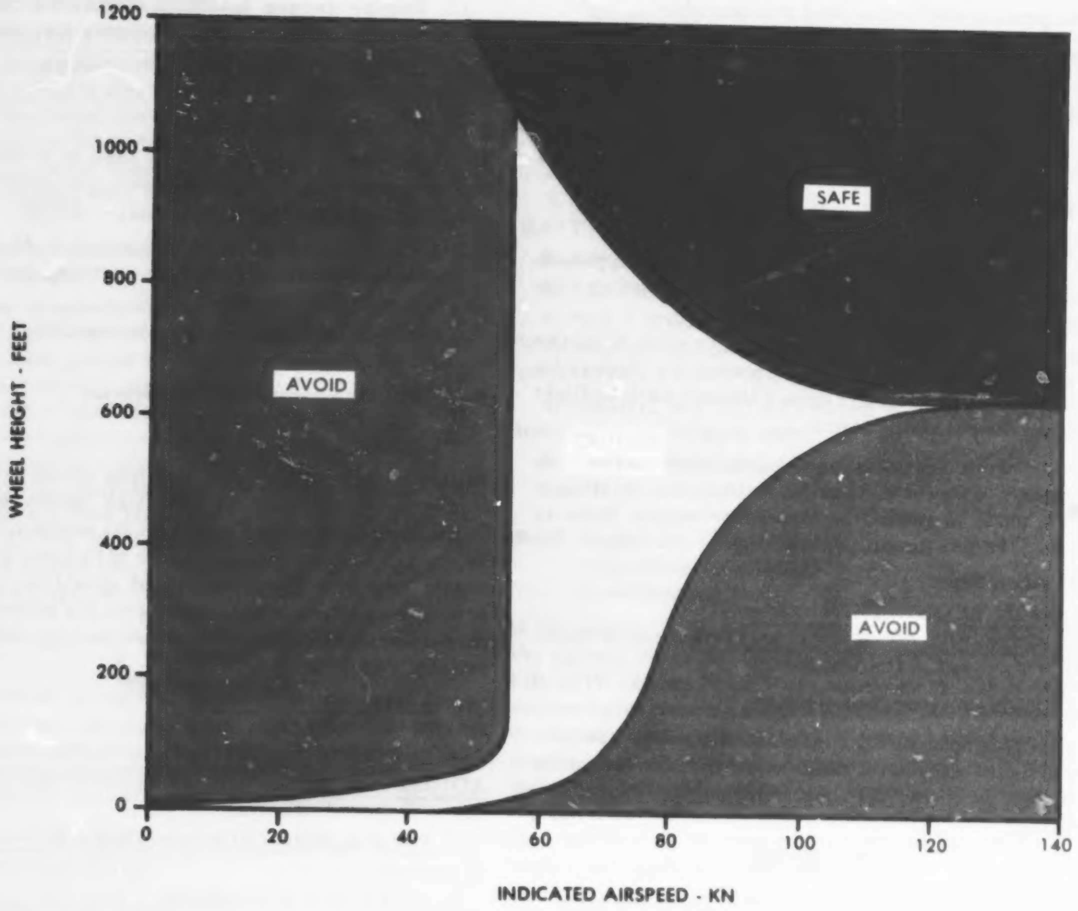

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Figure 9-6. Autorotational Approach Corridor for Second Engine Failure

If single-engine flight can be maintained and there are no indications of fire or mechanical malfunction, an attempt may be made to restart the inoperative engine. Refer to para 9-18, Engine Restart During Flight.

9-15. Failure of One Engine — Takeoff.

Refer to Failure of One Engine — Low Altitude/Low Airspeed (para 9-14).

9-16. Failure of One Engine — Cruise.

In cruise flight at airspeeds up to Vne, the thrust control should be lowered only enough to keep rotor rpm within normal limits as the operative engine beep trim is increased. Airspeed should be maintained at or above maximum rate of climb speed for the existing conditions. External cargo should be jettisoned as required to sustain single-engine flight. After single-engine flight has been established, secure the inoperative engine (Engine Cleanup), if time permits, and land as soon as practicable.

When an engine fails in cruise flight, proceed as follows:

1. Thrust control — Adjust as necessary to maintain rotor rpm.
2. ENGINE BEEP TRIM switch — RPM INCREASE as required.
3. External cargo — Jettison as required.
4. ALT switch — Disengage.
5. Land as soon as practicable. Perform an approach and landing with power. Refer to para 9-73, Landing with One Engine Inoperative.
6. Engine — Secure, using the Engine Cleanup Procedure (para 9-19). If time permits, the inoperative engine should be secured (Engine Cleanup) while in flight to reduce the possibility of fire.

If single-engine flight can be maintained and there are no indications of fire or mechanical malfunction, an attempt may be made to restart the inoperative engine. Refer to para 9-18, Engine Restart During Flight.

9-17. Abort Start.

1. ENGINE CONDITION lever — STOP.
2. ENGINE START switch — MOTOR if ptit is above 350°C; OFF after ptit is below 260°C.

9-18. Engine Restart During Flight.

If one engine fails during flight, and there are no indications of fire or mechanical malfunction, the pilot may make an attempt to restart the inoperative engine. Proceed as follows:

WARNING

> Fire detector and extinguishing systems are not provided for the apu. Crewman must monitor apu area for fire.

1. Apu — Start.

CAUTION

> If there are abnormal indications during the restart, shut down the engine immediately. Continue flight on one engine, if conditions allow, or land as soon as practicable.

2. ENGINE CONDITION lever, inoperative engine — STOP.
3. FIRE PULL handle — In.
4. All FUEL PUMPS switches — ON.
5. CROSSFEED FUEL VALVES switch — As required.
6. ENGINE START switch — MOTOR.
7. ENGINE CONDITION lever — GROUND. At 10 to 15% N1, start switch to START immediately. Release START switch to MOTOR prior to ptit reaching 450°C. When N1 is 50 percent, set START switch to OFF. Check STARTER ON caution light out.
8. Engine oil pressure — Check.
9. Engine instruments — Check when stabilized at ground idle.
10. ENGINE CONDITION lever — FLIGHT.
11. Rotor rpm — Set as required.
12. Engine torque match. Cross-check with gas producer speed. Matched engine torques may result in a slight gas producer speed mismatch.
13. Apu — OFF.

9-19. Engine Cleanup Procedure.

The following procedures will be used to secure the inoperative engine(s) after engine failure, time permitting:

1. ENGINE CONDITION lever(s) — STOP.
2. CROSSFEED FUEL VALVES switch — As required. Close when crossfeeding fuel to the operative engine is not required and when both engines fail.
3. FUEL PUMPS switch(es) — As required.

9-20. Normal Engine Beep Trim System Failure (High Side) or N2 Governor Failure.

Failure of the normal engine beep trim system to the high side may be recognized by increasing torque on the affected engine, decreasing torque on the unaffected engine, an increase in rotor rpm, and a lack of response of normal engine beep trim. These indications should be confirmed by observing all the engine instruments. If a malfunction of the normal engine beep trim system to the high side occurs, perform the following:

1. Thrust control — Adjust as required to maintain rotor rpm within limits.
2. ENGINE CONDITION lever (affected engine) — ADJUST to a position between FLIGHT and GROUND that will control rotor rpm.
3. ENGINE BEEP TRIM switch NO. 1 & 2 — ADJUST as required.
4. Land as soon as practicable.

Controlling rotor rpm with the ECL must be done smoothly and with care. Engine response is much faster and it is possible to cause the rotor rpm to exceed limitations and decrease to the point that the generators will be disconnected from the busses. If the thrust control is moved, it is necessary to control rotor rpm with the engine condition lever since the droop eliminator on the affected engine will be disabled. Match torque using the No. 1 & 2 NORMAL ENGINE BEEP TRIM SWITCH.

9-21. Normal Engine Beep Trim System Failure (Low Side or Static).

Failure of the normal engine beep trim system to the low side can be recognized by decreasing torque on the affected engine, increasing torque on the unaffected engine, a loss of rotor rpm, a lack of response to normal engine beep trim and N1 stabilized at or above ground idle (60 to 63% N1). These indications also accompany an engine failure; therefore, engine instruments must be monitored to determine which event has occurred. A static failure may be recognized by failure of affected engine to respond to normal beep commands or may resemble a high or low side failure when the thrust control is lowered or raised. If beep trim system fails, perform the following:

1. EMERG ENG TRIM switch (affected engine) — ADJUST as required.
2. EMERG ENG TRIM AUTO/MANUAL switch (affected engine) — MANUAL.
3. EMERG ENG TRIM switch (affected engine) — INC or DECR in coordination with the ENGINE BEEP TRIM NO. 1 & 2 switch to obtain operating rotor rpm and match torque. If the thrust control is moved with either EMERG ENG TRIM AUTO/MANUAL switch in MANUAL, it is necessary to control rotor rpm and torque by use of the appropriate EMERG ENG TRIM INC or DECR switch.

9-22. Engine Transmission Clutch Failure to Engage.

An engine transmission clutch failing to engage is most likely to occur when the engine condition lever is advanced from ground to flight or during engine start. The indications of an engine transmission clutch failing to engage are; a loss of torque indication for an engine or erratic torque indications for an engine or failure of the N1 of an engine to respond to engine beep trim inputs. A sudden high torque clutch-engagement may cause severe engine and/or drive train damage. A sudden engagement is indicated by a loud noise and/or a sudden large increase in engine torque. Should the engine transmission fail to engage, perform the following:

WARNING

Do not shutdown both engines simultaneously. Maintain rotor RPM with the engaged engine until affected engine N1 reaches zero (0).

1. ENGINE CONDITION lever (affected engine only)—STOP.

   When N1 reaches zero (0):

2. ENGINE CONDITION lever (engaged engine)—STOP.

9-23. Engine Shutdown — Complete Electrical Failure.

Should a complete electrical failure be experienced, use the following procedure to shut down the engines:

1. Fuel valves — CLOSE. The flight engineer manually closes the fuel valves which are in the aft cargo compartment. Since the fuel valves are located approximately halfway between the engines and the fuel tank, the engines will continue to operate for a period of time, depending on the power setting when the fuel valves are closed.
2. Continue with normal shutdown.

9-24. Engine Shutdown — Condition Lever Failure.

Should the engine condition lever fail to shut down or control an engine, use the following procedure for engine shutdown.

1. FIRE PULL handle (affected engine) — Pull.
2. Continue with normal shutdown.

9-25. Engine Shutdown With Apu Inoperative.

Apply external electrical and hydraulic power (if available) and continue with a normal shutdown. If external electrical and hydraulic power is not available, proceed as follows:

1. No. 2 Engine — Perform a normal shutdown.
2. All unnecessary electrical switches — OFF. The BATT switch shall be left ON.
3. LEFT SIDE FUEL PUMPS switches — OFF.
4. NO. 1 and NO. 2 GEN control switches — OFF.
5. NO. 1 ENGINE CONDITION lever — GROUND. Wait until ptit decreases and then begins to increase; then, move the NO. 1 ENGINE CONDITION lever to STOP.
6. ENGINE NO. 1 START switch — MOTOR until rotors stop or ptit is below 260°C.
7. Continue with normal engine shutdown.

9-26. Engine Oil — Low Quantity/High Temperature/High or Low Pressure.

A low engine oil quantity condition will be indicated by the lighting of the NO. 1 ENG OIL LOW or NO. 2 ENG OIL LOW caution light. When either one or both of these caution lights come on, about 2 quarts of usable oil remain in the respective engine oil tank. If one or both of the caution lights come on, check oil temperature and oil pressure indicators (affected engine) for abnormal indications. If the indication on the oil temperature indicator is high or the indication on the oil pressure indicator exceeds limits, high or low, perform the following:

1. **If engine is required for flight:**

   Land as soon as possible.

2. **If engine is not required for flight:**

   a. **ENGINE CONDITION lever (affected engine) — STOP.**

   b. **Land as soon as practicable.**

9-27. Engine Chip Detector Caution Light ON.

If either NO. 1 or NO. 2 ENG CHIP DET caution light comes on, perform the following:

1. If engine is required for flight:

   Land as soon as possible.

2. If engine is not required for flight.

   a. ENGINE CONDITION lever (affected engine) — STOP.

   b. Land as soon as practicable.

9-28. Torque Measuring System Malfunctions.

Malfunctions in the torque measuring system can appear on the torquemeter as fluctuations, a zero-torque indication, sluggish movement, indications which are out-of-phase, or a stationary indication. Fluctuations in torque at steady state are indicative of an electrical malfunction within the system. If this occurs, proceed as follows:

1. AC and DC TORQUE circuit breakers — In.
2. N1 — Monitor when power changes are made or power outputs are matched.
3. Land as soon as practicable.

9-29. ROTOR, TRANSMISSION, AND DRIVE SYSTEMS.

9-29.1 Transmission Debris Screen Latches

Trouble developing in any of the five transmissions may be indicated by a tripped latch indicator. This information will be presented on the flight engineers maintenance panel but will not be shown in the cockpit. Therefore, if a debris indicator trips, the flight engineer should advise the pilots. If a debris screen indicator trips, attempt one reset with the GND TEST SWITCH. If the indicator does not reset, proceed as follows:

1. FWD, COMB, AFT

   Land as soon as possible.

2. Left or right engine transmission.

   a. Engine required for flight.

   Land as soon as possible.

   b. Engine not required for flight. Engine condition lever (affected engine) — STOP.

   Land as soon as practicable.

9-30. Transmission Low Oil Pressure or High Temperature Indications.

Developing trouble in the transmissions can be identified by high oil temperature or low oil pressure, as indicated by transmission temperature and pressure indicators and caution lights. If an abnormal temperature or pressure indication develops, closely monitor the caution lights. The XMSN OIL PRESS and XMSN OIL HOT caution lights operate independently of the pressure and temperature indicating system and come on when a low pressure or high temperature condition occurs. Additional information may be obtained by the flight engineer checking the maintenance panel. The transmission temperature and pressure selector switches shall be used to assist in determining the defective transmission.

9-31. XMSN OIL PRESS Caution Light On.

1. If low oil pressure is not indicated in any position, confirm aft vertical shaft low oil pressure with the flight engineer.

   Land as soon as possible.

2. If the LT or RT engine transmission is indicated, proceed as follows:

   If the engine is required for flight:

   Land as soon as possible.

   If the engine is not required for flight:

   a. ENGINE CONDITION lever (affected engine) — STOP.

   b. Land as soon as practicable.

3. If the FWD or MIX transmission is indicated, proceed as follows:

   a. Altitude — Descend to minimum safe altitude.

   b. Airspeed — 100 KIAS or below.

   c. Land as soon as practicable.

4. If the AFT transmission is indicated:

   Land as soon as possible.

9-32. XMSN OIL PRESS and XMSN AUX OIL PRESS Caution Lights On.

Land as soon as possible.

9-33. XMSN OIL HOT Caution Light On.

1. If FWD or MIX transmission is indicated:

   Land as soon as possible.

2. If the Aft transmission is indicated:

   a. Electrical load reduce.

   b. Land as soon as possible.

3. If the LT or RT engine transmission is indicated, proceed as follows:

If the engine is required for flight:

Land as soon as possible.

If the engine is not required for flight:

a. ENGINE CONDITION lever (affected engine) — STOP.

b. Land as soon as practicable.

9-34. NO. 1 or NO. 2 ENG XMSN HOT Caution Light On.

1. ENGINE CONDITION lever (affected engine) — STOP.

2. Engine transmission — Check. The flight engineer will visually check the affected engine and engine transmission for fire.

3. Land as soon as possible.

9-35. XMSN AUX OIL PRESS Caution Light On.

1. If main transmission oil pressure and temperature are abnormal:

Land as soon as possible.

2. If main transmission oil pressure and temperature are normal:

Land as soon as practicable.

9-36. XMSN CHIP DET Caution Light On. **If the XMSN CHIP DET caution light comes on, land as soon as possible.**

9-36.1 XMSN DEBRIS LATCH INDICATOR (Maintenance Panel) Will Not Reset. **If latch indicator cannot be reset, land as soon as possible.**

9-37. ROTOR BLADES OR DRIVE FAILURE.

If a rotor blade or drive shaft fails, land as soon as possible.

9-38. Single or Dual Rotor Tachometer Failure.

If one or both rotor tachometers fail, proceed as follows:

Land as soon as practicable. Do not attempt further changes in rotor speed. All maneuvers requiring use of the thrust control must be made smoothly to prevent rotor droop or overspeed.

9-39. Ground Resonance.

Helicopters with improperly serviced lag dampers and landing gear can be forced into a slightly unstable condition when all landing gear are on the ground with the forward landing gear in light contact during takeoffs and landings. The response of the helicopter is a rolling motion. In no case should rotor rpm be decreased to control the instability nor should a full setdown be attempted since divergency can occur under these conditions. If divergency occurs:

Thrust — Increase to become airborne and stabilize the helicopter.

9-40. Blade Stall.

Blade stall is indicated by a progressive increase of *1-per-rev* and *3-per-rev* vibrations. The severity of vibrations will increase as the helicopter is flown further into blade stall. If blade stall is experienced, executing one or more of the following will ease the condition:

1. Thrust control — Lower.
2. Rotor rpm — Increase.
3. Airspeed — Decrease.
4. Maneuvering — Minimize.
5. Altitude — Descend if practicable.

9-41. FIRE.

The safety of aircraft occupants is the primary consideration when fire occurs; therefore, it is imperative that every effort be made by the flight crew to put out the fire. On the ground, it is essential that engines be shut down, crew and passengers evacuated, and fire fighting begun immediately. If time permits, a *Mayday* radio call should be made before electrical power is OFF to expedite assistance from airfield fire fighting equipment and personnel. If the aircraft is airborne when fire occurs, the most important single action that can be taken by the pilot is to land the helicopter immediately. Whether on the ground or in flight, it is mandatory that cockpit windows, air control handles, and cockpit air knobs be closed to prevent smoke entering the cockpit. Fire extinguishers should be used to control or extinguish the fire.

WARNING

> Use fire extinguisher only in well ventilated areas because the toxic fumes of the extinguisher agent can cause injury.

9-42. ENGINE FIRE.

9-43. Engine Residual Fire During Starting and Shutdown.

A residual engine fire can occur during a start or shutdown. It is usually caused by residual fuel igniting in the combustion chamber. The fire will be indicated by a rapid and abnormal rise in ptit or by flame and black smoke coming from the tail pipe. Should a fire occur, complete the following on the affected engine.

1. ENGINE CONDITION lever — STOP.
2. ENGINE START switch — MOTOR until ptit indicates approximately 260°C.
3. FIRE PULL handle — Pull.
4. Continue with a normal shutdown.

9-44. Auxiliary Power Unit (Apu) Fire.

Normally an overtemperature condition will cause the overtemperature switch to stop apu operation; however, should a fire occur in the apu, complete the following:

1. APU switch — STOP.
2. ENGINE CONDITION levers — STOP if engines are operating.
3. ENGINE START switch(es) — MOTOR as required to prevent internal fire.
4. Clear the helicopter of all passengers and crew immediately.
5. BATT switch — OFF.

9-45. Engine Fire — Flight.

Fire will be indicated by visible flames or smoke on the outside of the engine or by the lighting of the respective fire detector light in the cockpit. If an engine fire occurs, perform the following on the affected engine:

1. Land as soon as possible.
2. Engine(s) — Check. The flight engineer will visually check the engines to confirm the fire.
3. ENGINE CONDITION lever (affected engine) — STOP.
4. FIRE PULL handle (affected engine) — Pull.
5. FIRE EXT AGENT switch — Select as required. Depending upon the severity of the fire, it may be necessary to use both bottles.
6. ENGINE CONDITION levers — STOP after landing.
7. Clear the helicopter of all passengers and crew immediately.
8. BATT switch — OFF.

9-46. Engine Fire — Ground.

If an engine fire occurs, perform the following:

1. ENGINE CONDITION levers — STOP.
2. FIRE PULL handle (affected engine) — Pull.
3. FIRE EXT AGENT switch — Select as required. Depending upon the severity of the fire, it may be necessary to use both bottles.

4. Clear the helicopter of all passengers and crew immediately.

5. BATT switch — OFF.

9-47. *Fuselage Fire — Ground.*

If fire is observed in any part of the fuselage during ground operations, proceed as follows:

1. ENGINE CONDITION levers — STOP.
2. Clear the helicopter of all passengers and crew immediately.
3. BATT switch — OFF.

9-48. *Fuselage Fire — Flight.*

If fire is observed in any part of the fuselage during flight, attempt to control it by using portable hand fire extinguishers and proceed as follows:

1. Land as soon as possible.
2. ENGINE CONDITION Levers — STOP after landing.
3. Clear the helicopter of all passengers and crew immediately.
4. BATT switch — OFF.

9-49. ELECTRICAL FIRE.

9-50. *Electrical Fire — Flight.*

In the event of electrical fire or suspected electrical fire in flight, proceed as follows:

1. Land as soon as possible.
2. Airspeed — 100 KIAS or below.
3. Altitude — Descend below 6,000 feet pressure altitude.

NOTE

Longitudinal cyclic trim and dash actuators will remain programmed at the airspeed at which the generators were turned off.

4. GEN control switches — OFF. If the flight is being conducted above 6,000 feet pressure altitude, delay turning the generators off until below 6,000 feet pressure altitude since the fuel boost pumps will become deenergized and a dual flameout could possibly result. Do not turn off the generators when IMC.
5. ENGINE CONDITION levers — STOP after landing.
6. Clear the helicopter of passengers and crew immediately.
7. BATT switch — OFF.

9-51. *Electrical Fire — Flight Continued.*

If landing cannot be made and flight must be continued, the defective equipment must be identified and shut down.

9-52. *Electrical Fire — Ground.*

In the event of electrical fire or suspected electrical fire during ground operations, proceed as follows:

1. ENGINE CONDITION levers — STOP, if engines are operating.
2. APU switch — OFF, if operating.
3. Clear the helicopter of passengers and crew immediately.
4. BATT switch — OFF.

9-53. *Smoke and Fume Elimination.*

1. Airspeed — 80 to 100 KIAS.
2. Cargo loading ramp — Open.
3. Upper half of main cabin door — Open.
4. Helicopter attitude — 20° left yaw.
5. Pilot's sliding window — Open. Simultaneous opening of the pilot's sliding window and the main cabin door and cargo loading ramp may cause a smoldering fire to intensify. If the source of the smoke cannot be ascertained, close the pilot's sliding window.
6. Copilot's sliding window — Closed.

9-54. FUEL SYSTEM.

9-55. Aux Fuel Pump Failure.

An auxiliary fuel pump failure will be indicated by an AUX PRESS caution light, on the FUEL CONTROL panel, coming on and/or the fuel quantity in the affected tank remaining at the same level. Should this occur, proceed as follows:

1. Fuel quantity selector switch — Check the fuel quantity in each auxiliary fuel tank on the affected side. If one or both auxiliary fuel tanks have fuel remaining, proceed as follows:
2. AC-DC FUEL PUMPS circuit breakers — Check in.
3. FWD or AFT AUX FUEL PUMPS switch (affected side) — OFF. Both AUX FUEL PUMPS switches must be OFF whenever the following check will be made. Perform the following for each AUX tank which has fuel remaining.
4. AUX FUEL PUMPS switch — ON. Check the AUX PRESS caution light. If the light remains on, this indicates that the auxiliary fuel pump is inoperative.
5. AUX FUEL PUMPS switch(es) — ON for operative pumps — OFF for inoperative pumps.

9-56. *Fuel Venting.*

Fuel venting from either main tank vent indicates a dual failure of the tank float valve/shutoff valve when transferring fuel from auxiliary to main tanks. If this failure occurred, about 9 GPM would be vented without overpressurizing the main tank. Should venting occur during flight, proceed as follows:

1. AUX FUEL PUMPS switches (affected side) — OFF.
2. Use fuel until 1,000 pounds remains in main tank (affected side).
3. AUX FUEL PUMPS switches — ON.
4. Main tank fuel quantity—Monitor. When 1,600 pounds of fuel is in main tank, stop pumps.
5. Repeat steps 1 thru 4 until auxiliary tanks are EMPTY.

9-57. *Fuel Pump System Failure.*

Should both main tank fuel pumps fail, fuel will be supplied to the engines from each main tank through a bypass check valve as long as the helicopter is operated below 6000 feet pressure altitude. The L or R FUEL PRESS caution light will come on. If this occurs, proceed as follows:

1. CROSSFEED FUEL VALVES switch — OPEN above 6000 feet pressure altitude. Check FUEL PRESS caution light — Out.
2. AC and DC FUEL PUMPS circuit breakers — Check in. If a pump is operational, proceed with step 3. If not, proceed with step 4.
3. CROSSFEED FUEL VALVES switch — CLOSED.
4. FUEL PUMPS switch(es) — OFF (inoperative pump(s)).

9-58. *Fuel Low Caution Light On.*

If an L FUEL LOW or an R FUEL LOW caution light comes on, perform the following:

1. CROSSFEED FUEL VALVES switch — OPEN.
2. Avoid nose high attitudes.

9-59. ELECTRICAL SYSTEM.

9-60. *NO. 1 or NO. 2 GEN OFF Caution Light ON.*

If a GEN OFF caution light comes on, the corresponding rotor tachometer may also fail.

Perform the following:

1. GEN control switch (affected generator) — TEST.

If the caution light goes out:

2. GEN control switch — ON.

If the caution light remains on:

2. **GEN control switch — OFF.**
3. **Land as soon as practicable.**

A bus tie will be indicated by the illuminatin of the NO. 1 or NO. 2 GEN OFF caution light only, no loss of any other system. If other system caution light comes on, or a system is lost, a bus tie does not exit.

4. **Land as soon as possible.**

9-61. *NO. 1 and NO. 2 GEN OFF Caution Lights ON.*

Should both generators fail, both transformer-rectifiers will also be disabled and the rotor tachometers may fail. Consequently, the only electrical power available will be 24-volt dc from the battery. This condition will be indicated by loss of both AFCS and the lighting of both AFCS OFF, GEN OFF, and RECT OFF caution lights. A simultaneous failure of both AFCS can also result in an abrupt aircraft attitude change as the integrated lower control actuators center. Perform the following:

NOTE

> Longitudinal cyclic trim and dash actuators will remain programed at the airspeed at which the generators failed. If the failure occurs at high speed (cyclic actuators extended), helicopter response will be similar to that discussed in para 9-79.

1. Airspeed — 100 KIAS or below.
2. Altitude — Descend below 6,000 feet pressure altitude.
3. AFCS switch — OFF.
4. EMERG ENG TRIM switches — As required.
5. Land as soon as possible. If unable to land, proceed with steps 6 thru 9.
6. GEN control switches — TEST. Move each GEN control switch to TEST. If the GEN OFF caution light goes out, the generator is delivering proper voltage and frequency and a short circuit on a bus is indicated. If the caution light remains on, the generator is inoperative. If both generators remain inoperative go to step 10. If one or both of the generators are delivering proper voltage and frequency, continue as follows:
7. AC BUS TIE gang bars — Down. When the gang bars are down, bus-tie is disabled. This is done to prevent either generator from being disabled again by a fault on a non-associated bus.
8. GEN control switches — RESET then ON. The generator which will not stay on the line feeds the bus on which the short has occurred. There is a possibility that the electrical difficulty can be isolated to a faulty system or circuit breaker.
9. Generator system fault — Isolate as follows:
    - a. GEN control switch — OFF.
    - b. Circuit breakers — Pull out all circuit breakers on the associated power distribution panel.
    - c. GEN control switch — RESET then ON.
    - d. Circuit breakers — Push in one circuit breaker at a time until the malfunctioning equipment can be identified.
    - e. AC BUS TIE gang bars — Up.
10. If steps 6 thru 9 were unsuccessful and electrical power is required, complete the following:

WARNING

> Fire detector and extinguishing systems are not provided for the apu. Crewman must monitor apu area for fire.

a. APU switch — START.

b. APU GEN switch — ON.

9-62. NO. 1 or NO. 2 RECT OFF Caution Light ON.

If a RECT OFF caution light comes on, proceed as follows:

1. AC-DC circuit breakers — In.

WARNING

If a dc bus-tie does not occur, power to open the cargo hooks in normal mode is not available. Refer to para 9-96, Jettisoning External Cargo.

If a bus tie has not occurred, other caution lights will be on, such as L FUEL PRESS (if crossfeed fuel valves are closed), NO. 1 AFCS OFF.

2. Land as soon as possible.

If a dc bus tie has occurred, only the RECT OFF caution light will be on.

2. Land as soon as practicable.

NOTE

If a bus tie does not occur, the hydraulic oil cooler fan(s) will not function.

9-63. NO. 1 and NO. 2 RECT OFF Caution Lights On.

When both transformer-rectifiers fail, all equipment on the No. 1 and No. 2 dc buses will be disabled. Equipment which will be lost includes all fuel boost pumps, both AFCS, accompanied by abrupt attitude change, both torque indicators, and normal engine beep trim. Therefore, changes in power settings should be minimized. The only source of dc power is the battery. Should both transformer-rectifiers fail, perform the following:

1. AC-DC circuit breakers — In. If both caution lights remain on, proceed as follows:
2. Airspeed — 100 KIAS or below.
3. Altitude — Descend below 6,000 feet pressure altitude, if possible.
4. AFCS SYSTEMS SEL switch — OFF.
5. Land as soon as possible.
6. All dc equipment not essential to flight — OFF. Pull out circuit breakers, if necessary.

9-64. BATT SYS MAL Caution Light On.

Depending on battery charge at time of failure, the battery bus may be disabled. The only circuits on the battery bus are the hydraulic oil level indicators and the emergency apu start circuit. If the BATT SYS MAL caution light comes on, proceed as follows:

1. BATT CHGR circuit breaker — Out then in.

If the BATT SYS MAL caution light remains on:

2. BATT switch — OFF.

9-65. Hydraulic System.

WARNING

The power transfer pumps were designed for ground checkout of the flight control system and have the capacity to pressurize the system in flight for normal maneuvers only. Use of the power transfer pumps in flight is restricted to these emergency conditions only.

9-66. NO. 1 or NO. 2 HYD FLT CONTR Caution Light On.

a. If a caution light comes on, and fluid loss is evident:

Land as soon as possible.

b. If a caution light comes on and fluid loss is not evident, proceed as follows:

1. POWER XFR switch (affected system) — ON.
2. Monitor fluid level and pressure of affected system on maintenance panel (Flight Engineer).
3. Land as soon as possible.

9-67. NO. 1 and NO. 2 HYD FLT CONTR Caution Lights On.

If both hydraulic systems fail, flight controls cannot be moved. In addition, the NO. 1 and NO. 2 AFCS-OFF caution lights will illuminate. If this occurs, proceed as follows:

1. POWER XFR NO. 1 and NO. 2 switches — ON.
2. Land as soon as possible. Avoid large control inputs.

9-68. UTIL HYD SYS Caution Light On.

Depending upon the nature and location of the system failure, it may not be possible to operate the following items of equipment: auxiliary power unit, engine starters, ramp and cargo door, wheel brakes, swivel locks, power steering, cargo hook, ptu's and winch. Should a failure occur in either of these subsystems, turn the corresponding isolation switch OFF. This prevents loss of fluid and pressure from the rest of the system. Prior to landing, the pilot should direct the flight engineer to determine whether sufficient pressure (3,000 psi) is available in the apu start accumulator. If accumulator pressure has decreased, the flight engineer should attempt to repressurize it using the hand pump. It will be necessary to open the EMERG UTILITY PRESS valve and continue pumping to maintain pressure. If brakes or power steering is not available, landing from a hover is recommended. A running landing without wheel brakes and swivel locks operating is not recommended because it may require large directional pedal inputs, resulting in damage to or loss of the droop stops. Proceed as follows:

a. If fluid loss is evident:

Land as soon as possible.

b. If high fluid temperature is evident:

Land as soon as possible.

c. If fluid loss is not evident:

1. APU — Start
2. Land as soon as practicable.

best copy available

Monitor fluid level, pressure, and temperature of affected system on maintenance panel (Flight Engineer).

After landing, the wheels should be chocked immediately.

9-69. Landing and Ditching.

WARNING

External loads shall be jettisoned prior to landing in trees or ditching.

9-70. Emergency Descent.

WARNING

In executing any emergency descent, regardless of engine power available, it is imperative that the helicopter be maneuvered into a position from which a survivable landing can be accomplished. Transition from the following descent techniques into an appropriate landing attitude/airspeed/rate-of-descent should begin prior to descending below 600 feet AGL. The emergency descent procedures below will result in rates-of-descent which exceed the rates displayed on the vertical speed indicator.

An emergency descent is a maximum performance maneuver in which damage to the helicopter or power plants must be considered secondary to getting the helicopter on the ground. No one procedure can be considered best for all given situations. The pilot must consider his flight profile in selecting the emergency descent procedure he will execute. Rotor RPM greater than 102 percent significantly increases airframe vibrations and should serve as a good rotor RPM cue during the maneuver. The following techniques will produce the highest acceptable rates-of-descent from higher altitudes.

a. High Speed Straight Ahead Descent: This procedure produces the highest rates of descent but also produces high airspeeds which must be dissipated prior to landing. The actual touchdown area may vary from the apparent touchdown point due to the glide angle change during the initial deceleration to reduce high airspeed.

1. Thrust Control – Lower. Adjust rotor RPM to maintain approximately 104 percent.

2. Airspeed – Adjust (approximately 130 to 150 KIAS).

3. Recovery – Initiate at or above 600 feet AGL and decelerate to 70-80 KIAS to enter the autorotative corridor (figure 9-6).

NOTE

Allowing the rotor RPM to increase during deceleration will reduce the floating effect which will occur when the deceleration is initiated.

b. Out-of-Trim Descent: This procedure places the helicopter in a high rate-of-descent and allows simultaneous execution of smoke and fume elimination procedure. In addition, it allows good landing area predictability.

1. Thrust Control – Lower. Adjust rotor RPM to maintain approximately 104 percent.

2. Airspeed – Adjust to maintain approximately 100 KIAS.

3. Trim – Adjust cyclic and pedals to obtain a minimum of one ball width out of trim to the right (left pedal forward) equivalent to a bank angle of approximately 8 degrees - 10 degrees right and a zero turn rate.

4. Recovery – Initiate at or above 600 feet AGL, retrim the ball to centered flight and adjust airspeed to approximately 70 KIAS. (See figure 9-6).

c. Low Speed Maneuvering Descent: Maneuvering the helicopter in steep turns as described below should allow the pilot to maneuver the helicopter over his intended landing area during the descent, observe his area of intended touchdown, and make adjustments as required.

1. Thrust Control – Lower. Adjust rotor RPM to maintain approximately 102 percent.

2. Airspeed – Adjust to maintain 70-90 KIAS.

3. Bank Angle – Adjust as required. Bank angles of up to 60 degrees will result in the desired rates-of-descent.

4. Recovery – Initiate at or above 600 feet AGL. Aircraft should be returned to wings level.

9-71. Autorotative Landing.

An autorotative landing will be accomplished after failure of both engines. Maintain airspeed at or above the minimum rate of descent airspeed in autorotation with cyclic. Maintain rotor rpm below 108 percent by adjusting thrust as necessary. Do not allow rotor rpm to decay below 91 percent prior to deceleration for touchdown.

At approximately 50 to 75 feet above ground level, apply aft cyclic control as necessary (not to exceed 20° nose-high attitude) to initiate a smooth deceleration. Maintain alinement of the helicopter with the landing area by application of pedals and cyclic control. Position thrust as required to prevent rotor rpm from increasing above the maximum.

At approximately 15 feet aft gear height, apply sufficient thrust to slow the rate of descent, assist deceleration, and effect a smooth touchdown in effective translational lift. The amount of thrust applied and the rate at which it is applied will vary depending upon the wind, load, and other influencing factors. Maintain the landing attitude, if possible, with cyclic and thrust until forward speed has ceased, then smoothly lower thrust until the forward landing gear touches the ground. Apply brakes as required.

Whenever a touchdown into the wind under fully controlled conditions cannot be made, execute a crosswind landing. It is better to perform a crosswind landing, which can be executed from sufficient altitude to stop drift and reduce the rate of descent, than to continue a turn into the wind with the great possibility of a hard landing and damage to the helicopter. Decelerate the helicopter at the same altitude as though the helicopter were making the entire approach into the wind.

Stop all drift and perform the initial touchdown on the upwind aft landing gear. In a strong wind it may be necessary to hold the helicopter in what is, in effect, a slip by cross control.

After touchdown, allow the helicopter to settle on the other landing gear. Perform the ground roll in the same manner as a landing made into the wind.

9-72. Landing With Flat Tires.

Should a tire or tires become deflated during flight or on touchdown, do not attempt a roll-on landing or taxiing on the affected gear. Land on sod or dirt, whenever possible, to prevent damage to the wheels.

9-73. Landing With One Engine Inoperative.

When committed to a single-engine landing, it is not always possible to terminate the approach at a hover. Therefore, if terrain conditions allow, a running landing or an approach which terminates on the ground is recommended. Establish a shallow angle of descent at or above maximum endurance or rate of climb airspeed. Govern the rate of descent and airspeed according to gross weight, density altitude, and terrain. At approximately 100 feet, begin a slow deceleration while reducing the rate of descent. Prior to touchdown, make sure the helicopter is alined with the direction of movement. Increase thrust as necessary for a smooth touchdown at or above effective translational lift. After touchdown has been made on the aft landing gear, maintain this attitude until speed is sufficiently slow. Then lower the thrust control smoothly until the forward landing gear are on the ground. Apply brakes as required. To ensure response to pilot and AFCS control inputs and prevent droop stop pounding, maintain thrust above the ground detent position. When forward motion has stopped (after landing), smoothly lower thrust control to the ground detent.

a. Landing in trees — Power on.

If a landing in a heavily wooded area is imminent, it is best to land while power is still available. Make a power-on approach, bringing the helicopter to a hover at tree-top level, and proceed as follows:

1. ENGINE CONDITION levers — STOP.
2. Thrust control — Increase before contact with trees and allow the helicopter to settle in a level attitude.
3. Clear the helicopter of passengers and crew immediately.

b. Landing in trees — Power off.

If it is necessary to make an autorotative landing in a heavily wooded area, proceed as follows:

1. Land. Accomplish an autorotational approach so that forward speed is stopped at tree-top level.
2. Thrust control — Increase before contact with trees and allow the helicopter to settle in a level attitude.
3. Clear the helicopter of all passengers and crew immediately.

9-74. Emergency Entrance.

(See fig. 9-2.)

Access to the cockpit is thru the pilot and copilot jettisonable doors. The cargo compartment is entered by opening the cabin door, upper cabin door escape hatch, cabin escape hatch, ramp escape hatch, and cutout panels. All escape hatches can be opened by pulling out the yellow tab and pushing in the panel.

9-75. Ditching.

There is sufficient buoyancy and lateral righting moment to remain afloat and upright long enough to permit safe egress of crew and passengers.

9-76. Ditching — Power ON.

When ditching is to be accomplished while power is still available, plan the approach so that the final descent is made at 90° to the primary wave pattern and terminates in a hover 5 to 10 feet above the water. When stabilized in hover, the pilot may, at his discretion, order the passengers to commence egress or wait until the helicopter is in the water and the rotors have stopped turning. If ditching becomes necessary, proceed as follows:

1. Land away from personnel in the water.
2. ENGINE CONDITION levers — STOP after helicopter has settled in the water.
3. BATT switch — OFF.
4. Clear the helicopter of passengers and crew. Refer to figure 9-7 for ditching exits.

9-77. Ditching — Power OFF.

If dual engine failure occurs over water and ditching is imminent, execute an autorotational descent, maintaining airspeed at or above minimum rate-of-descent airspeed and rotor rpm in normal operating range by adjusting thrust as necessary.

At approximately 100 feet above the water, perform a smooth deceleration to reduce the airspeed and rate of descent. During the deceleration, rotor rpm will start to increase. Allow rotor rpm to increase to the upper limit so that maximum benefit can be derived from inertia to cushion the touchdown.

At approximately 30 feet above the water, the final attitude should be adjusted, not to exceed 20° nose-up. An excessive nose-up attitude will reduce the clearance between the water and the aft rotor, and concentrate impact forces on the aft fuselage.

Rate of descent should be the minimum attainable at water entry and must be considered regardless of water-entry speed.

Water-entry speed is equally important and should be as low as possible without sacrificing aircraft control.

Helicopter attitude at water entry is very important and relates directly to water-entry speed. At zero entry speed or at speeds up to 30 knots, the pitch attitude at water entry is dictated primarily by the clearance between the water and the aft rotor blades and should not exceed 20° nose-up. Entry speeds up to approximately 40 knots require a pitch attitude of approximately 15° to prevent high concentrated impact loads on the extreme aft bottom of the fuselage. However, it is also important not to allow the pitch attitude to become less than approximately 5° at the higher water-entry speeds since there is a possibility of breaking the lower nose enclosure plastic panels and a severe pitch down will occur when the forward landing gear enters the water.

The actual touchdown on the water will probably be governed by one of two conditions: high wind and rough water or low wind and calm water.

a. High wind and rough water. Use thrust as necessary to minimize rate of descent at water entry. Do not hesitate to use the remaining thrust at water entry if the rate of descent is judged to be excessive.

b. Low wind and calm water. Follow the procedure above to the point of the deceleration. Reduce speed to approximately 40 knots and then establish a nose-up attitude of approximately 5° to 10°. Just prior to water entry, increase thrust to cushion the aft landing gear contact with water. Attempt to have the rate of descent as low as possible when using this technique. As the helicopter decelerates, attempt to hold the nose out of the water. As the speed diminishes to 10 knots or less, lower the thrust control smoothly and return the controls to neutral. The helicopter does not display any tendency to pitch down upon water entry as long as the forward landing gear is held clear of the water. If the forward gear contacts the water above about 10 knots, a severe pitch down will occur. Also, the aft landing gear acts to create a decelerating force on the water. If ditching becomes necessary, proceed as follows:

1. Land. Accomplish an autorotational approach and landing.

2. Thrust control — Increase as necessary to minimize rate of descent at water entry.

3. BATT switch — OFF.

4. Clear the helicopter of passengers and crew. Refer to figure 9-7 for ditching exits.

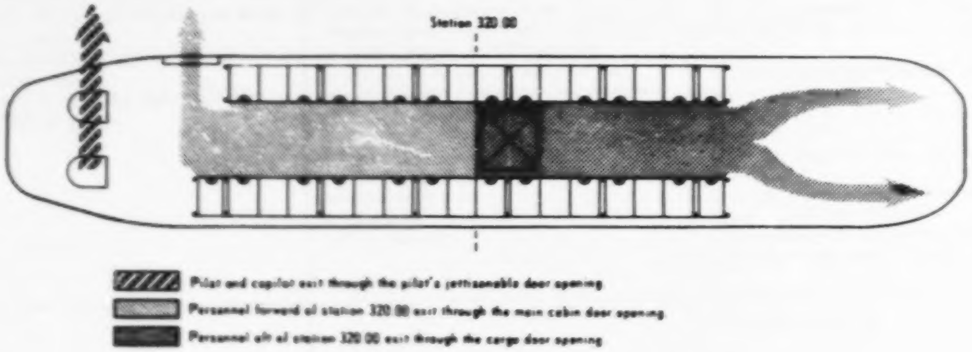
Station 320.00
▨ Pilot and copilot exit through the pilot's jettisonable door opening
▒ Personnel forward of station 320.00 exit through the main cabin door opening
▓ Personnel aft of station 320.00 exit through the cargo door opening

Figure 9-7. Ditching Exits

9-78. *Duties After Ditching.*

The pilot in command is responsible for the overwater mission briefing to ensure that each individual has a knowledge of what he is expected to do after leaving the helicopters. See fig. 9-8, Ditching Chart.

9-79. FLIGHT CONTROLS.

9-80. *Longitudinal Cyclic Trim System Failure.*

Longitudinal cyclic trim failure will be indicated by failure of the cyclic trim indicator pointers to move when making a speed change at AUTO or trim change at MANUAL. Should the system fail during cruise, with the cyclic trim system programed for maximum forward tilt of the rotors, an abnormal nose-up attitude will result with decreasing airspeed. Should one or both cyclic actuators fail in full retract position, airspeed must be limited according to Vne for retracted longitudinal cyclic trim (chapter 5). Do not use the cruise guide indicator to determine airspeed or maneuvering limits. Should the longitudinal cyclic trim system fail, perform the following:

1. Airspeed — Adjust. Airspeed must be below Vne for retracted cyclic trim, if failure occurs retracted. Maintain airspeed above 60 KIAS until landing approach if the failure occurs extended.

2. CYCLIC TRIM circuit breakers — In. If cyclic trim operation is not restored, proceed with a. below for lct failure in the AUTO mode or b. below for lct failure in MAN mode.

a. If in AUTO mode:

3. CYCLIC TRIM switch — MANUAL.

4. FWD and AFT CYCLIC TRIM switches — Manually extend for airspeeds above 60 KIAS or retract and maintain airspeed below Vne for retracted lct.

If lct operation is not indicated.

5. FWD and AFT CYCLIC TRIM switches — Manually retract for 30 seconds.

6. Airspeed — Remain below Vne for retracted lcts.

	PILOT	COPILOT	FLIGHT ENGINEER/ TROOP COMMANDER
DUTY	1. Notify the crew on interphone of the decision to ditch. 2. Adjust shoulder harness, life vest, and lock inertia reel. 3. Coordinate with the flight engineer/troop commander as required.	1. Notify the passengers of the decision to ditch by ringing the alarm bell 3 times. 2. Set the transponder (IFF) at EMER. 3. Initiate a distress message on the emergency frequency or a frequency on which previous contact has been made. 4. Relieve the pilot of the controls while he adjusts his shoulder harness. 5. Adjust shoulder harness, life vest, and lock the inertia reel. 6. Just prior to water contact, ring the alarm bell continuously.	1. Notify the passengers of the impending ditching and check that each is properly strapped in. 2. If cargo is to be jettisoned, coordinate on interphone with the pilot. 3. If the cargo is not to be jettisoned, check it for proper restraint. 4. Close the ramp and cargo door and all hatches and doors. 5. Assemble all emergency equipment and distribute it among the passengers. 6. Fasten safety belt and advise the pilot that the cabin is prepared for ditching.
PROVIDE	—	—	1. Emergency equipment.
POSITION	1. Pilot's seat.	1. Copilot's seat.	1. Cabin seat, near ramp or cabin door.
EXIT	1. Pilot's jettisonable door.	1. Pilot's jettisonable door.	1. Ramp or cabin door. See figure 9-7 for recommended emergency exits for ditching. Jettison cargo door. Do not lower ramp.

D145-80-10

Figure 9-8. Ditching Chart

b. If in MANUAL mode:

3. CYCLIC TRIM switch — AUTO.

If normal lct operation is not indicated:

4. CYCLIC TRIM switch — MANUAL.

5. FWD and AFT CYCLIC TRIM switches — Manually retract both lcts for 30 seconds.

6. Airspeed — Remain below Vne for retracted lcts.

If both actuators are retracted, the landing will be normal. If one or both actuators fail in extended position, the pitch attitude of the aircraft will be higher than normal during the approach and will be dependent upon the amount of actuator extension at the time of the failure. Execute a shallow approach to a hover or to the ground with a normal touchdown, avoiding large cyclic changes. When the aft gear are on the ground, apply brakes and lower the nose. As the forward gear touch the ground, the aircraft will tend to accelerate more than normal. Continue to apply brakes as necessary to prevent forward movement. If the helicopter is taxied with the actuators failed in the extend position, use minimum control applications and adjust the thrust control at the ground detent or higher. There is an increased susceptibility to droop-stop pounding with this condition.

9-81. Single AFCS Failure — Both ON.

A malfunction of the AFCS can usually be detected by an abrupt attitude change (hardover) or unusual oscillations in one or more of the flight control axes or by lighting of the NO. 1 or NO. 2 AFCS OFF caution light. However, certain failures (such as a dash failure) may not be recognized immediately because of gradual onset. Hand-on control monitoring is required. Should a malfunction occur, perform the following: (If any of the following steps result in regained control, do not continue with the remaining steps.)

1. Airspeed — Reduce to 100 KIAS or below.
2. Altitude — Adjust as required.
3. AFCS SYSTEM SEL switch — NO. 1 ON then NO. 2 ON to isolate defective system. A hardover in the opposite direction may occur when the malfunctioning AFCS is turned off and the functioning AFCS reacts on the flight controls.
4. AFCS SYSTEM SEL switch — Select operating system.

9-82. Dual AFCS Failure.

If the second AFCS fails while operating with one AFCS (one system inoperative), perform the following:

1. AFCS SYSTEM SEL switch — OFF.

9-83. (Deleted)

9-84. Vertical Gyro Malfunction.

A vertical gyro malfunction will be indicated by an attitude indicator failure, an AFCS OFF caution light on, and attitude transients. If a vertical gyro failure occurs, proceed as follows:

CAUTION

Failure of the No. 1 vertical gyro with altitude hold engaged, may result in an altitude runaway. If this occurs, disengage ALT HOLD.

NOTE

Failure of a vertical gyro results in loss of its associated AFCS and should be treated as a single AFCS failure.

1. Airspeed — 100 KIAS or below.
2. Affected VGI switch — EMER.
3. AFCS — Select remaining system.

9-85. Differential Airspeed Hold Failure.

Differential airspeed hold failure will be recognized by pitch attitude deviations. If DASH failure occurs, avoid nose high attitudes.

9-86. Altitude Hold Failure. Altitude hold failure will be recognized by a loss of altitude hold, a creeping thrust control, or a rapid change in altitude or torque. Should altitude hold fail, perform the following:

1. BARO ALT/RAD ALT switches — Disengage.
2. Thrust control — Adjust as required.

9-87. Heading Select Failure.

Heading select failure will be recognized by a constant turn (turning past selected heading) or no turn when bug is set at selected heading and CMD SEL switch depressed. If this condition should occur, perform the following:

HDG switch — DISENGAGE.

9-88. Cockpit-Control Driver Actuator Failure.

If the thrust cockpit-control driver actuator fails, it will slip when a force between 10 and 20 pounds is applied to the thrust control. If the longitudinal cockpit control driver actuator fails, it can be recognized by loss of pitch trim or failure of the centering device to release. A centering spring in the pitch axis allows these forces to be overcome.

9-89. Bailout — Crew/Passengers.

Refer to exits available in fig. 9-2. For rapid crew emergency exit, jettison the pilot's and copilot's jettisonable doors and release the safety belt and shoulder harness. When releasing the safety belt for emergency exit, throw the ends outward so that the parachute harness will not catch on the adjustment buckles of the shoulder harness. Bail out by grasping the door frame with both hands, pull out of the seat, and exit head first. An alternate method is to grasp the upper door frame and exit backwards. Make a short free fall before opening the parachute to prevent entanglement with the helicopter. Passengers should bail out through the nearest available exit after being notified by a crewmember.

When the pilot in command determines that bailout is necessary, accomplish the following:

1. Doors — Jettison or open.
2. Airspeed — 80 KIAS.
3. TROOP ALARM switch — Ring to notify passengers.
4. Crew (except pilot) and passengers — Bail out through nearest exit.
5. Flight controls — Trim.
6. Pilot — Bail out.

SECTION II MISSION EQUIPMENT

9-90. Armament.

9-91. Armament Subsystems — M24 and M41.

9-92. Misfire.

Should there be a hangfire or cook-off, proceed as follows:

1. Area — Clear. Keep the weapon trained on the target and all personnel clear of the muzzle.

WARNING

> Do not retract the bolt assembly immediately when a hangfire or cook-off is suspected. A hangfire will normally occur within 5 seconds from the time the primer is struck. A cook-off will normally occur after 10 seconds of contact with the chamber of a hot barrel. If 150 cartridges are fired in a 2-minute period, the barrel will be hot enough to produce a cook-off.

2. Bolt — Retract, remove cartridge. After removal from the weapon, the cartridge must be kept separate from all other ammunition until it has been determined whether the cartridge or the firing mechanism was at fault. If it is determined that the cartridge is at fault, it will be retained separate from other cartridges until disposed of. On the other hand, if examination reveals that the firing mechanism was at fault, the cartridge may be reloaded and fired, after correction of the cause for failure to fire.

9-93. Runaway.

If the machine gun continues to fire after the trigger assembly has been released, break the ammunition belt.

9-94. Cargo.

9-95. Jettisoning Internal Cargo.

If it becomes necessary to jettison internal cargo to reduce gross weight for improved single-engine performance or because of other inflight emergencies, jettison as appropriate thru nearest exit.

9-96. Jettisoning External Cargo.

9-97. Cargo Hooks.

The following methods should be used when jettisoning external cargo from any of the three hooks.

WARNING

> If the DUAL HOOK FAULT caution light is on, normal and emergency release capability for the forward and aft hook is lost. Use the manual emergency release system only. Release the center hook first if it is loaded or safety sling is attached.

a. Primary Method.

1. CARGO HOOK EMERG switch — REL ALL.
2. Load — Check released. If the forward or aft hook did not open because of sling slack, apply a slight amount of thrust to load the hook and pull it open. Crewmembers must remain clear of the mid cargo hook. If jettisoning becomes necessary, the hook may spring back when the load is released, resulting in injury.

b. Alternate Method. (DUAL HOOK fault light ON.)

1. Mid hook emergency release handle (D ring) — Pull.
2. Forward and aft hook release lever — Pull aft to release cargo from forward and aft hooks.
3. Loads — Check released. If the forward or aft hooks did not open because of sling slack, apply a slight amount of thrust to load the hook and pull it open.

9-98. Hoist.

Use the following procedures when jettisoning cargo on the hoist:

1. Personnel — Clear. Personnel must remain aft of the rescue hatch and face away from the cable cutter. The hoist cable may whip forward when it is cut and particles may be ejected from the cable cutter.
2. CABLE CUTTER switch — ON.
3. Load — Check released.

APPENDIX A

REFERENCES

This appendix contains a list of official publications referenced in this manual and available to and required by CH-47D helicopter operating activities. The publications listed are directly related to flight operation and maintenance of CH-47D helicopters.

AR 70-50	Designating and Naming Military Aircraft, Rockets, and Guided Missiles
AR 95-1	Army Aviation — General Provisions and Flight Regulations
AR 95-16	Weight and Balance Army Aircraft
AR 385-40	Accident Reporting and Records
DA PAM 738-751	The Army Maintenance Management System — Aviation (TAMMS-A)
FMI-230	Meterology for Army Aviation
FMI-240	Instrument Flying and Navigation for Army Aviators
FM 55-450-1	Helicopter External Loads
FM 55-450-2	Helicopter Internal Loads
TB 55-1500-334-25	Conversion of Aircraft to Fire Resistant Hydraulic Fluid
TB 55-9150-200-24	Engine and Transmission Oils, Fuels, and Additives for Army Aircraft
TM 9-1005-224-10	Machine Gun, 7.62 MM, M60
TM 38-250	Preparation of Hazardous Materials for Military Aircraft
TM 55-410	Aircraft Maintenance, Servicing, and Ground Handling Under Extreme Environmental Conditions
TM 55-1500-204-25/1	General Aircraft Maintenance Manual
TM 55-1500-210-L	List of Applicable Publications for CH-47D Helicopters
TM 55-1500-342-23	Army Aviation Maintenance Engineering Manual: Weight and Balance
TM 55-1520-240-CL	Operators and Crewmembers Checklist
TM 55-1680-358-12 & P	Operator and Aviation Unit Maintenance Instructions for Helicopter Internal Cargo Handling System
TM 750-244-1-5	Procedures for the Destruction of Aircraft and Associated Equipment to Prevent Enemy Use

APPENDIX B

GLOSSARY

ABBREVIATION	TERM
ac	alternating current
adf	automatic direction finding
AFCS	advanced flight control system
aft	the after end
AIMS	altitude information monitoring system
alt	altitude
am	amplitude modulated
amp.	ampere
ant	antenna
apu	auxiliary power unit
approx	approximately
as	airspeed
ASTM	American Society for Testing Materials
auto	automatic
aux	auxiliary
avail	available
bcn	beacon
bfo	beat-frequency oscillator
brt	bright
btry	battery
btu	British thermal unit
C	Celsius
carr	carrier
cas	calibrated airspeed
cdr's	commander's
C.G.	center-of-gravity
cgi	cruise guide indicator
chan	channel
chk	check
ckpt	cockpit
℄	center line
comp	compass
comp't	compartment
cont	control
ctr	center
dash	differential airspeed hold
dc	direct current
dcp	differential collective pitch
dec	decrease
det	detector
dim.	dimensions
dis	disable
dn	down
emer	emergency
eng	engine
exh	exhaust
ext	extend, extinguisher, or external
f	fast
fat	free air temperature
fdr	feeder
fig.	figure
fil	filament
fl	flow
flt	flight
flt cont	flight control
fm	frequency modulated
fpm or ft/min	feet per minute
ft	feet
fuse.	fuselage
fwd	forward
g	green
g's	gravity
gals.	gallons
gca	ground controlled approach
gd xmit	guard transmitter
gen	generator
grd	ground
gr wt	gross weight
gyro(s)	gyroscope(s)
hdg	heading
hf	high frequency
hg	mercury
hgt	height
hi	high
HICHS	helicopter internal cargo handling system
HIGE	hover in ground effect
HOGE	hover out of ground effect
hr	hour
hsi	Horizontal situation indicator
htr	heater
hyd	hydraulic
ias	indicated airspeed
ident	identification
iff	identify friend or foe
ifr	instrument flight regulations
ige	in ground effect
igv	inlet guide vane
ign	ignition
ilca	integrated lower control actuator
ils	instrument landing system
IMC	instrument meteorological conditions
in. or "	inch
inc	increase
ind	indicator
inst	instruments
int or inph	interphone
ito	instrument takeoff
JP-4, JP-5 or JP-8	jet petroleum

ABBREVIATION	TERM
kHz	kilohertz
KIAS	knots indicated airspeed
kn	knots
lb	pound(s)
lb-ft	pound-feet (torque)
lb/gal	pounds per gallon
lb/hr	pounds per hour
lg	length
lh	left-hand
loc	location
long. cyc	longitudinal cyclic
lts	lights
lvl	level
man.	manual
max.	maximum
MHz	megahertz
med	medium
mil	angular measurement, military
min	minute(s) or minimum
mkr bcn	marker beacon
mm	millimeter
mom	momentary
mom. on	momentary on
mwo	modification work order
N	North
nac	nacelle
nav	navigation
no	number
norm	normal
nvg	night vision goggles
N1	gas producer (speed)
N2	power turbine (speed)
obs	omni bearing selector
obst	obstacle
oge	out-of-ground effect
op	operate
outb'd	outboard
ovhd or ovrhd	overhead
ovsp	overspeed
para	paragraph
ph	phase
plt	pilot
P/N	Part Number
pnl	panel
pph	pounds per hour
press.	pressure
pri	primary
psf	pounds per square foot
psi	pounds per square inch
pt	pint
ptit	power turbine inlet temperature
ptt	push-to-talk
ptu	power transfer unit
pvt	private
pwr	power
qt	quart
qty	quantity
r	red
r or rt	right
rad	radar
rc	rate of climb
rcvr	receiver
rd	rate of descent
recp or rec	receptacle
rect	rectifier
ref	reference
rel	release
ret or retr	retract
retrans or re-x	retransmission
rev cur	reverse current
rf	radio frequency
rh	right-hand
rpm	revolutions per minute
s/op	slow operation
sec	secondary
sect	section
shp	shaft horsepower
sif	selective identification feature
sl	sea level
S/N	serial number
slt	searchlight
spec	specification
sph	spheroid
sq	squelch or square
sq ft	square feet
sta	station
stby	standby
sys	system
t/r + g	transmit/receive plus guard channel
tach	tachometer
tas	true airspeed
tck	track
temp	temperature
tor/eng	torque per engine
uhf	ultra high frequency
ut or util	utility
utm	universal transverse mercator
vac	volts alternating current
vdc	volts direct current
vent.	ventilate
vfr	visual flight regulations
Vh	Maximum airspeed in level flight (as limited by CGI, PTIT, or Torque).
vhf	very high frequency
vgi	vertical gyro indicator
Vmax	Maximum airspeed limit (indicator red line).
Vne	velocity (airspeed) never exceed
vol	volume
vor	very high frequency omni-directional range
warn.	warning
wshld	windshield
wt	weight
x	times or by
x-feed	crossfeed

ABBREVIATION	TERM
xmit	transmit
xmsn	transmission
xtk/tke	gross track/track angle error
°	degrees or temperature
°C	degrees Celsius
°/kts	degrees per knots
%	percent
3/rev	three vibrations for each revolution of the rotor

ALPHABETICAL INDEX

Subject — Para, Fig., Table Number

A

Abbreviations B-1
Abbreviations for Performance Charts 7-10
Abort Start Procedure 9-17
AC System 2-192
  External power caution light 2-195
  Generator caution lights 2-194
  Generator control switches 2-193, F2-33
  Power supply F2-30
Advanced Flight Control System (AFCS) 2-103
  Altitude hold 2-107
  Control panel 2-111, F2-23
  Caution lights 2-115
  Command select switches 2-117
  Cyclic trim indicators 2-114
  Cyclic trim switches 2-113
  Differential airspeed hold (DASH) 2-106
  Heading select 2-108
  Operation 2-119
Aerobatics Prohibition 5-23
After Landing 8-44
Aircraft Designation System 1-11
Airspeed Indicator 2-244, F5-1
Airspeed Limits 5-20
  AFCS limitations 5-22
  With cyclic trim retracted 5-21 F5-6
  Inoperative cruise guide indicator 5-20, F5-5
Alternate Fuel 2-265
Altimeter-AIMS 2-245, F2-43
  In-flight operation 2-247
  Preflight operation 2-246
Altimeter, Radar 2-248, F2-44
  Control and function 2-249
Altimeter-Standard 2-247
Altitude Limitations 5-29
ALSE Aviation Life Support Equipment 8-2
Ammunition 4-32
Antenna Locations F3-3
Anticollision Lights 2-209, F2-38
  Switches 2-210
Anti-Ice Requirements, Bypass Panels T5-1
Anti-Ice Requirement, Engine T5-1
Anti-Icing Systems 2-146
  Engine 2-43
  Engine anti-ice switch 2-44
  Pitot tube and SAS yaw port 2-148
  Pitot heat switch 2-149
  Structural 2-147
  Windshield 2-150
  Windshield switches 2-151
Appendix A, References A-1
Appendix B, Glossary B-1
Apu (Auxiliary Power Unit)
  Apu ON caution light 2-203
  Control box 2-201
  Control switch 2-202, F2-33
  Fire 9-38
  General 2-200, F2-36
  Manual fuel shutoff valve 2-204, F2-37
  Operation in flight 5-45
  Starting 8-23
Armament Subsystem (M-24) 4-17, F4-8
  Data T4-1
  Inflight Operation 4-31
  Operation 4-28
  Preflight checks 4-29
Armament Subsystem (M41) 4-33
  Data T4-3
  Machine gun 4-34
  Operation 4-38
Army Aviation Safety Program 1-7
Ash Trays 2-173
Assist Straps, Pilots 2-175
Attitude Indicator (ID-1000) 2-252, F2-45
  Gyro failure 9-83
  VGI switch 2-253
Autorotative Landing 9-71
Avionics 3-1
Ax 2-39

B

Bailout 9-88
Bank Limitations 5-24
Basic Weight and Balance Record (Chart C) 6-2
Battery Switch 2-197
Battery System Malfunction Caution Light 2-199

Subject — Para., Fig., Table Number

- Beep Trim 2-51
  - Disable switches 2-52
  - Emergency trim switches 2-53
  - Normal beep trim system failure 9-20
- Before Leaving Helicopter 8-46
- Before Landing Check 8-40
- Before Starting Engines 8-22
- Before Takeoff 8-29
- Before Taxi 8-25
- Blade Stall 9-40
- Blade Track (Strobex) Receptacles 2-172, F2-28
- Fuel Pumps 2-74
  - System failure 9-57
- Brake Pedals 2-12
- Brake System 2-11
  - Isolation switch 2-10
  - Parking brake caution light 2-14
  - Parking brake handle 2-13
- Buffer Boards 6-64

C

- Cabin and Ramp Lights 2-232
- Cabin Door 2-17
- Cabin Utility Receptacle 2-156
- Cable Cutter 4-43, F4-25
- Cargo Hook System, Triple 4-50
  - Cargo hook limitations 5-18
  - Dual hook fault caution lights 4-57
  - Emergency operation 9-96
  - Operational check 4-58
  - Preflight check 8-10
- Cargo Loading 6-31
  - Allowable loading limits F6-30
  - Cargo compartment 6-32, F6-11
  - Cargo compartment floor 6-36
  - Cargo loading aids 6-48
  - Compartment capacities 6-44
  - Compartment identification 6-43
  - Concentrated loads 6-40
  - Concentrated load limits 6-41
  - Five thousand-pound capacity tiedown fittings 6-46
  - Helicopter Internal Cargo Handling System Loading Sequence 6-101.2
  - Load limits 6-42
  - Lower rescue door 6-35
  - Main cabin entrance 6-33
  - Strength areas 6-37
  - Ten thousand-pound capacity tiedown fittings 6-47
  - Tiedown fittings 6-45
  - Uniformly distributed loads 6-38
  - Uniformly distributed load limits 6-39
  - Utility hatch door 6-34
- Cargo Loading Ramp 6-49
  - Accumulator gage 6-61
  - Auxiliary loading ramps 6-50
  - Cargo door and ramp 6-53
  - Comfort provisions 6-65
  - Equipment loading and unloading 6-69
  - Hydraulic hand pump 6-58
  - In-flight operation 6-72
  - Manual control valve 6-59
  - Manual operation-cargo door 6-73
  - Normal operation 6-71
  - Pressure actuated valve 6-57
  - Ramp controls 6-54, F6-18
  - Ramp control sequence valve 6-56, F6-19
  - Ramp control valves 6-55
  - Ramp isolation switch 6-60
  - Ramp operation 6-70
  - Tiedowns 6-52
  - Winch 6-51
- Cargo Preparation 6-74
  - Balance (helicopter cg) 6-83
  - Bulk cargo tiedown 6-100
  - Calculation of tiedown devices required 6-97
  - Cargo dimensions 6-75
  - Cargo cg 6-78
  - Cargo weight 6-76
  - Compartment loading 6-86
  - Contact pressure 6-77
  - Effect of tiedown devices at angles 6-95
  - General cargo tiedown 6-101
  - General instructions 6-81
  - Hazardous cargo 6-80
  - Load planning 6-85
  - MB-1 tiedown device 6-93
  - CGU-IB tiedown device 6-94
  - Restraint 6-84
  - Restraint criteria 6-91
  - Extended Range Fuel System (ERFS) 6-101.1
  - Restraint devices 6-92
  - Rules for application of tiedown devices 6-96
  - Securing cargo 6-90
  - Shoring 6-89
  - Station loading 6-87
  - Tiedown methods 6-98
  - Vehicle load 6-79
  - Vehicle loading 6-88
  - Vehicle tiedown 6-99
  - Weight (helicopter) 6-82
  - Weight and Balance (HICHS) T-6-2
- Centering Device Release Switches 2-100
- Chart C-Basic Weight and Balance Record 6-6
- Cg Limitations 5-16
- Change Symbol Explanation 1-10
- Chapter 7 Index 7-1
- Checklist 8-9
- Chip Detectors, Engine 2-71

Subject — Para, Fig., Table Number

- Circuit Breaker (PDP) Panels F2-31, F2-32
- Climb 8-36
- Clock 2-257
- Cockpit Rearview Mirror 2-167
- Cockpit Utility Receptacle 2-169
- Cold Weather Operations 8-58
  - After landing 8-68
  - Before leaving helicopter 8-70
  - Descent 8-66
  - During flight 8-65
  - Engine shutdown 8-69
  - Engine starting 8-61
  - Landing in snow 8-67
  - Takeoff 8-64
  - Taxiing 8-63
- Communications/Navigation Equipment T3-1
- Compartment Loading F6-23
- Compass Correction Card 2-174
- Console F2-6
- Contact Pressure (Floor) 6-77
- Continuous Torque Available 7-20
- Covers, Protective 2-284, F2-54
- Crew
  - Minimum requirement 8-3
  - Responsibilities 8-3
- Crew Duties 8-3
  - Copilot 8-3
  - Flight engineer 8-3
  - Pilot 8-3
- Cross Feed Fuel Valve 2-78, F2-15
- Cruise 8-37
  - Cruise check 8-38
- Cruise Guide Indicator System 2-241, F2-42
  - Indicator 2-242
  - Test switch 2-243
- Cyclic Stick 2-98, F2-22

D

- Danger Areas F8-2, F8-3
- DC System 2-196
  - Battery switch 2-197
  - Battery system malfunction caution light 2-199
  - External power caution light 2-195
  - Transformer-rectifier caution lights 2-198
  - Power supply F2-35
- Defueling Valve 2-82, F2-18
- Descent 8-39
- Desert Operation 8-86
  - Before leaving aircraft 8-94
  - Engine shutdown 8-93
  - Engine starting 8-89
  - General 8-87
  - Landing 8-92
  - Preparation for flight 8-88

Subject — Para, Fig., Table Number

  - Takeoff, climb, cruise, and descent 8-91
  - Taxiing 8-90
- Destruction of Army Material to Prevent Enemy Use 1-8
- Dimensions, Principle F2-2
- Direction Finder Set (AN/ARN-89) 3-25, F3-10
  - Controls and function 3-26
  - Normal operation 3-27
- Directional Gyro F3-12
- Directional Pedals 2-102
- Discrete Signal Discriminator 3-4
- Distributed Loads 6-38
  - Limits 6-39
- Ditching 9-75
  - Power OFF 9-77
  - Power ON 9-76
- Ditching Chart F9-8
- Ditching Exits F9-7
- Dome Lights 2-224
  - Dimming rheostat 2-226
  - Select switch 2-225, F2-39
- Doors
  - Cargo 6-53
  - Lower rescue 6-35
  - Main cabin 2-17
  - Pilots and copilots 2-19
  - Utility hatch 6-34
- Drive System Failure 9-30
- Droop Stop Shrouds 8-75
- Dynamic Absorbers, Self-Tuning 2-25

E

- Electrical Fire 9-49
  - Flight 9-50
  - Ground 9-52
- Electrical Power Supply System 2-191
  - Ac system 2-192, F2-34
  - Dc system 2-196, F2-35
- Electrical System Failure 9-59
  - Both generators 9-61
  - One generator 9-60
  - Both transformer rectifiers 9-63
  - Single transformer rectifiers 9-62
- Emergency
  - Descent 9-70
  - Engine shutdown, complete electrical failure 9-23
  - Engine trim switches 2-51
  - Entrances F9-2
  - Equipment-location F9-1
  - Escape and exit routes F9-7
  - Escape Ax 2-39
  - Exit lights 2-235
  - First aid kits 2-37
  - Floodlights 2-228
  - Fuel 2-265

Subject	Para, Fig., Table Number
Power system	2-235
Troop alarm and jump lights	2-33
Warning signals	9-4
Emergency Descent	9-70
Emergency Procedures	9-1
After emergency action	9-5
Armament	9-91
Bailout	9-89
Cargo	9-95
Electrical system	9-60
Engine	9-6
Fire	9-41
Flight controls	9-79
Fuel system	9-54
Hydraulic system	9-65
Immediate action checks	9-2
Landing and ditching	9-69
Rotor transmission and drive systems	9-29
Warning signals	9-4
Emergency Torque Available	7-7, F7-2
Conditions	7-13
Use of chart	7-12
Engine	2-40
Anti-ice requirements	T5-1
Anti-icing	2-43
Anti-ice switch	2-44, F2-8
Anti-icing limitations	5-47
Beep trim switches	2-50, F2-21
Condition levers	2-49, F2-11
Description, engines	2-40
Drain valves	2-73
Emergency power system	2-54
Fire	9-45
Fuel control units	2-47
Ground operation	8-24
Ignition lock switch	2-62
Inlet screens	2-42
Maintenance panel indicators	2-153
Oil Consumption	2-58
Oil system (servicing)	2-270
Overspeed	5-12, F5-1
Overtemperature	5-13, F5-1
Power control system	2-46
Power limits	5-10
Restart in flight	9-18
Shutdown	8-45
Shutdown-apu inoperative	9-25
Shutdown-condition lever failure	9-24
Shutdown-electrical failure	9-23
Starting	8-23
Starting system	2-59
Start panel	F2-13
Start switches	2-58
Engine drain valves	2-73
Engine Failure	9-6
Flight characteristics	9-7

Subject	Para, Fig., Table Number
Failure of one engine	9-13
Failure of one engine—low altitude/ low airspeed	9-14
Failure of one engine—cruise	9-16
Failure of one engine—takeoff	9-15
Failure of two engines—cruise	9-12
Failure of two engines—low altitude/ low airspeed	9-10
Failure of two engines—takeoff	9-11
Engine Fire	9-45
Engine Instruments and Indicators	2-63
Auxiliary tank pressure caution lights	2-87
Chip detector caution lights	2-69
Fuel quantity	2-83, F2-19
Fuel pressure caution lights	2-86
Gas producer tachometer	2-63
Oil level caution light	2-70
Oil pressure	2-68
Oil temperature	2-67
Torquemeters	2-65
Transmission temperature	2-140
Engine Interstage Air Bleed	2-72
Engine Oil—Low Quantity High Temperature—High or Low Pressure	9-26
Engine Overspeed	5-12
Engine Overtemperature	5-13
Engine Restart During Flight	9-18
Engine Shutdown	8-45
Apu inoperative	9-25
Complete electrical failure	9-23
Condition lever failure	9-24
Engine Transmission Temperature and Debris Detection System	2-136
Entrance to Helicopter	2-17
Environmental Restrictions	5-28
Altitude limits	5-29
Engine anti-icing limits	T5-1
Flight under IMC	5-30
Wind limits for starting rotor	5-49
Escape Ax	2-39
Equipment Serviceability Criteria	1-9
Exterior Check	8-15
External Power Receptacles	F2-30

F

Subject	Para, Fig., Table Number
Failure	
Generators (both)	9-60
Generator (one)	9-61
Heater	2-190
N2 overspeed drive shaft	9-21
Rotor blade or drive shaft	9-33
Transformer receifier (both)	9-59
Transformer rectifier (one)	9-58

Subject — Para, Fig., Table Number

- Fairing (Structural) Anti-Icing 2-145
- FAT (Free Air Temperature) Gage 2-147
- Fire 9-41
  - Apu 9-44
  - During engine start and shutdown 9-43
  - Electrical-flight 9-50
  - Electrical-ground 9-52
  - Engine-flight 9-45
  - Engine-ground 9-46
  - Fuselage-flight 9-48
  - Fuselage-ground 9-47
- Fire Extinguisher System 2-77, F2-9
  - Control handles 2-28
  - Control handle warning lights 2-29
  - Detector test switch 2-31
  - Engine compartment 2-26, F2-9
  - Engine fire extinguisher pressures T2-1
  - Extinguishing agent switch 2-30
  - Hand fire extinguishers 2-32
- First Aid Kits 2-37
- Fittings, Tiedown 6-84, F6-13
- Flare Dispenser M-130 4-8, F4-7
- Flight Characteristics, General 8-50
  - AFCS off flight characteristics 8-51
- Flight Control Hydraulic Systems 2-121
  - Flight control panel F2-24
- Flight Control Limitations 5-44
- Flight Control System 2-96
  - Advanced flight control system 2-103
  - AFCS OFF caution lights 2-115
  - Beep trim switches 2-99
  - Centering device release 2-100
  - Cyclic sticks 2-99, F2-22
  - Cyclic trim indicators 2-114
  - Cyclic trim switches 2-113
  - Directional pedals 2-102
  - Hydraulic systems 2-121
  - Thrust control brake 2-98
  - Thrust control 2-97, F2-21
- Flight Controls Failure 9-66
  - Differential airspeed hold 9-85
  - Dual AFCS failure 9-82
  - Longitudinal cyclic trim failure 9-80
  - Single AFCS 9-81
  - Cockpit control drive actuator 9-88
  - Vgi malfunction 9-83
- Flight Instrument Lights 2-218
  - Dimming rheostat 2-219
- Flight Instruments 2-240
  - Airspeed indicator 2-244
  - Altimeter-AIMS 2-245
  - Altimeter, radar 2-248
  - Attitude indicator (ID-1000) 2-252
  - Clock 2-257
  - Cruise guide indicator 2-242
  - Free air temperature 2-256
  - Magnetic compass 2-255
  - Turn and slip indicator 2-254
  - Vertical velocity indicator 2-251
- Flight In Thunderstorms 8-84
- Flight In Turbulent Air 8-81
- Flight Restrictions 8-2
- Flight With External
  - Aerodynamic loads 8-55
  - High density loads 8-54
  - Low density loads 8-53
  - Technique 8-56
- Floodlights 2-228
  - Dimming Rheostat 2-229
  - Selection switches 2-230
- FM Homing 3-12
- FM Radio Set (AN/ARC-164) 3-10, F3-4
  - Controls and functions 3-11
- Form F-Weight and Balance 6-7
- Formation Lights 2-207
  - Control switch 2-208, F2-39
- Forms and Records 1-9
- Free Air Temperature Gage 2-256
- Fuel Control Panel F2-14
- Fuel Control Units 2-47
  - Speed governing 2-48
- Fuel System 2-74, 2-87
  - Auxiliary tank pressure caution lights 2-85
  - Balancing 2-76
  - Controls and indicators 2-76
  - Crossfeed fuel valve switch 2-78
  - Crossfeed fuel valve indicating light 2-79
  - Fuel cell overpressure 9-56
  - Fuel flow indicators 2-88
  - Fuel pressure caution lights 2-86
  - Fuel pump switches 2-77
  - Fuel supply 2-74
  - Fuel types 2-265
  - Fuel valves 2-80, F2-17
  - Fuel valve warning lights 2-79, F2-16
  - Limitations 5-14
  - Manual defueling valve 2-82, F2-18
  - Pressure drop 9-55
  - Quantity caution light 2-85
  - Quantity indicator 2-83
  - Quantity selector switch 2-84
  - Servicing 2-267, T2-3
- Fuel System Failure 9-54
  - Auxiliary fuel pump failure 9-55
  - Fuel low caution light 9-58
- Fuel Weight and Moment 6-10, F6-4
- Fuselage Fire—Flight 9-48
- Fuselage Fire—Ground 9-47

Subject — Para., Fig., Table Number

G

- Gas Producer
  - Fuel control units 2-47
  - Overspeed F5-1
  - Speed governing 2-48
  - Tachometer 2-63
- General Arrangement F2-1
- General Instructions 1-1
  - Aircraft designation system 1-11
  - Appendix A, References A-1
  - Army aviation safety program 1-7
  - Change symbol explanation 1-10
  - Destruction of army material to prevent enemy use 1-8
  - Forms and records 1-9
  - Helicopter description 1-2
  - Index 1-6
  - Use of shall, should, and may 1-12
  - Warnings, cautions and notes 1-2
- Generators 2-192
- Gross Weight 2-2
- Gross Weight Limitations 5-17
- Ground Handling (Towing) 2-279
  - Alternate towing 2-281
  - Normal towing 2-280, F2-52
- Ground Clearances F2-2
- Ground Operation (Engine) 8-24
- Ground Resonance 9-39
- Ground Taxiing Limitations (Flight Controls) 5-27
- Gyrosyn Compass Indicator (ASN-43) 3-28, F3-11
  - Controls and function operating procedure 3-29

H

- Hand Fire Extinguisher 2-32
- Hazardous Cargo 6-80
- Heating and Ventilating System 2-176, F2-29
  - Air control handles 2-181
  - Cabin heat controls 2-182
  - Cockpit air knob 2-180
  - Emergency operation 2-190
  - Heat distribution 2-186
  - Heater caution light 2-183
  - Heater function switch 2-177
  - Heater overheat condition 2-190
  - Heater start switch 2-178
  - Normal operation 2-184
  - Starting 2-185
  - Stopping 2-187
  - Temperature selector 2-179
  - Vibrator contact failure 2-189
- Height Velocity 9-4, 9-7
- Helicopter Description 1-2
- Helicopter Internal Cargo Handling System 4-61
  - HICHS Cargo Types 4-62
  - System Configuration 4-63, F4-34
  - Hatch access 4-64
  - System Stowage 4-65
  - Loading Sequence 6-101.2
  - Extended Range Fuel System Restraint Criteria 6-101.1
  - Load Dumping from Ramp 6-101.9
  - Cargo Combinations F6-29.1
  - Loading Sequence Configurations T6-2
- HF Radio Set (AN/ARC-102) 3-19, F3-8
  - Controls and function 3-20
  - Normal operation 3-21
- High Density External Loads 8-54
- Hoisting System 4-44, F4-28
  - Controls 4-41
- Hovering
  - Hover check 8-28
  - Landing 8-41
  - Performance charts Chapter 7
  - Takeoff 8-30
- HSI 3-56, F3-14
- Hydraulic Fluid Tank Capacities T2-3
- Hydraulic Power Supply System 2-120
  - Brake and steer switch 2-126, F2-24
  - Caution lights 2-130
  - Flight control systems 2-121
  - Maintenance panel 2-153, F2-27
  - Power transfer unit switches 2-124
  - Ramp isolation switch 2-125
  - Service module 2-127
  - Utility hydraulic system 2-123
- Hydraulic System Failures 9-65

I

- Ice and Rain 8-85
  - Ice 8-86
  - Rain 8-87
- IFF System (AN/APX-100) 3-59
  - Computer 3-62
  - Controls and functions 3-63
  - Receiver-transmitter 3-61
  - Transponder control panel 3-60, F3-15
  - Normal operation 3-64
- Ignition Lock Switch 2-62
- IMC (Instrument Meterological Conditions) Capabilities 5-30
- Inertia Reels 2-24
- Inlet Screens 2-42
- Instrument and Control Panels 2-15, F2-6, F2-7, F2-8
- Instrument Flight 8-47
  - Flight procedures 8-48
  - Night flying 8-49

Subject	Para, Fig., Table Number
Instrument Lights	2-218
Dimming Rheostat	2-219
Instrument Markings	5-5, F5-1
Instrument Panel	F2-7
Interior Check	8-12

Subject	Para, Fig., Table Number
Maximum Torque Available (30 Minute Operation)	7-17, F7-4
Interphone System (C-6533/ARC)	3-4, F3-2
Controls and function	3-5
Discrete signal discriminator	3-4
Troop commander transmit switch	3-5

Subject — Para, Fig., Table Number

Introductory Material 1-3

J

Jettisonable Cargo Door 6-53
Jettisonable Pilots Doors 2-19
Jettisoning
  External cargo 9-96
  Internal cargo 9-95
Jump Lights 2-33
  Switch 2-33
Jump Seat 6-20

K

(Not Applicable)

L

Landing 8-41
  After landing 8-44
  Running landing to water 8-43
Landing Emergencies 9-68
Landing From a Hover to Water 8-42
Landing Gear System 2-3
Landing in Trees 9-73
Landing Searchlights 2-211
Landing Limitations 5-25
Landing With Flat Tires 9-71
Landing With One Engine
  Inoperative 9-72
Lighting
  Anticollision 2-209
  Cabin and ramp 2-232
  Center section instrument 2-220
  Console 2-222
  Dome 2-224
  Emergency exit 2-235
  Emergency floodlights 2-231
  Flight instruments 2-218
  Floodlights 2-228
  Formation 2-207, F2-38
  Jump 2-33
  Landing-searchlights 2-211
  Oil level check (transmission) 2-237
  Overhead panel 2-216
  Position (navigation) 2-205
  Searchlight 2-211
  Utility (C-4A), pilots' and copilots' 2-227
Lighting (NVG)
  Anticollision (NVG) 2-238.6
  Cabin and ramp (NVG) 2-238.28
  Center section instrument (NVG) 2-238.17
  Console (NVG) 2-238.19
  Dome (NVG) 2-238.21
  Emergency Exit (NVG) 2-238.30
  Emergency floodlights (NVG) 2-238.27
  Flight instruments (NVG) 2-238.15
  Floodlights (NVG) 2-238.24
  Formation (NVG) 2-238.3, F2-41.1
  Jump (NVG) 2-33
  Landing-searchlights (NVG) 2-238.8
  Oil level check (transmission) (NVG) 2-238.32
  Overhead panel (NVG) 2-238.13
  Position lights (NVG) 2-238.1
  Searchlight (NVG) 2-238.8
  Utility (C-4A), pilots' and copilots' (NVG) 2-238.23
Limitation 5-1
  Airspeed 5-20
  Environmental 5-28
  Height-velocity 9-7, F9-4
  Loading 5-16
  Maneuvering 5-23
  Power 5-10
Litters
  Arrangement 6-21, F6-6
  Combination seat and litter arrangement 6-28, T6-7
  Installation 6-25, F6-8
  Poles 6-23
  Removal 6-26
  Straps 6-24
  Support brackets 6-22
Loading Limits 6-102
  Center of gravity limits 5-16
  Loading limits chart F6-30
Loading Planning 6-85
Loading Pole F6-20
Low Density Loads 8-53
Low Oil Pressure/Quantity 9-26

M

M-24 Armament Subsystem 4-17, F4-8
Machine Gun (M60D) 4-18
  Misfire 9-91
  Runaway 9-92
Magnetic Compass 2-255
Main Cabin Door 2-17
Maintenance Panel 2-153, F2-27
Maneuvering Limits 5-23
  Aerobatics prohibition 5-23
  Bank angle limits 5-24, F5-7
  Flight control limits 5-26
  Ground taxi limits 5-27
  Landing limits 5-25
Map and Data Case 2-166
Master Caution System 2-258, F2-46
  Caution lights 2-60
  Caution test switch 2-261
  Dimming switch 2-262
  Master caution panel 2-259
Marker Beacon Receiver 3-22
  Controls and function 3-23
  Normal operation 3-24
Maximum Glide Distance-
  Power Off 9-9, F9-5
Minimum Rate of Descent-
  Power Off 9-8, F9-5
Mission Equipment Loading 6-30, F6-10
Mission Equipment Failure
  Armament 9-89
  Cargo 9-93

Subject — Para, Fig., Table Number

- Cargo Hook 9-96
- Mission Planning 8-1
  - Crew briefing 8-4
- Mooring 2-283, F2-53
  - Mooring data T2-6
- Multi-Hook Loads 8-57

N

- N1 Speed F5-1
- N2 Governor Failure 9-20
- Navigation Instruments 2-218
  - Position (Navigation) Lights 2-207, F2-38
  - Switch 2-206
- Night Operations on Water 5-35
- Normal Engine Beep Trim System Failure (High Side) 9-20
- Normal Engine Beep Trim System Failure Static (Low Side) 9-21
- Normal Procedures
  - Climb 8-36
  - Cold weather operation 8-58
  - Cruise 8-37
  - Descent 8-39
  - Desert and hot weather operation 8-71
  - Flight characteristics 8-50
  - Ice and rain 8-85
  - Instrument flight 8-47
  - Landing 8-41
  - Mission planning 8-1
  - Operating procedures and maneuvers 8-6
  - Preflight 8-10
  - Salt water operation 8-85
  - Takeoff 8-30
  - Thunderstorms flight in 8-84
  - Turbulent air 8-83

O

- Oil Systems (Servicing)
  - Apu 2-271, T2-3
  - Engine 2-270, T2-3
  - Transmission 2-272, T2-3
- Oil
  - Cooler inlet covers 2-284, F2-54
  - Engine oil consumption 2-58
  - Oil level caution light (engine) 2-70
  - Oil level check lights (transmissions) 2-237
  - Pressure indicator 2-68
  - Supply system 2-57
  - Temperature indicator 2-67
- Operating Limits and Restrictions 5-1
- Operational Limits, Exceeding 5-3

Subject — Para, Fig., Table Number

- Operating Weight (Helicopter) 6-34
- Overall Dimensions F2-2
- Overhead Panel Lights 2-216
  - Dimming rheostat 2-217
- Overhead Switch Panel F2-8
- Overspeed, Engine 5-23
- Overtemperature 5-13, F5-2

P

- Panel Lights 2-216
- Parking 2-282
  - Brake caution light 2-14
  - Brake handle 2-13
- Partial Power Descent 9-69
- Passenger Briefing 8-5
- Performance Data 7-1
  - Airspeed calibration 7-41, F7-69
  - Climb-descent 7-35, F7-65
  - Continuous torque available 7-20, F7-5
  - Drag 7-32, F7-64
  - Emergency torque available 7-11, F7-2
  - Hover 7-23, F7-6
  - Idle fuel flow 7-38, F7-67
  - Takeoff 7-26, F7-8
  - Takeoff and intermediate torque available 7-16
- Performance Data Index 7-2
- Performance Planning Abbreviations 7-4
- Personnel Loading and Unloading 6-12, F6-5
  - Litter loading 6-12
  - Safety belts 6-18
  - Seating arrangement 6-14
  - Troop loading 6-19
  - Weight computation 6-13
- Pilot's and Copilot's Seats 2-20
  - Fore-and-aft lever 2-21
  - Rotation lever 2-23
  - Vertical lever 2-22
- Pilots Assist Straps 2-175
- Pitot Tube and AFCS Sideslip Port Anti-Icing 2-148
- Pitot Tube Cover 2-281
- Position Lights 2-207
  - Switch 2-206
- Power control System 2-46
- Power Limits 5-10
  - Engine overspeed 5-12
  - Engine overtemperature 5-13
  - Gas producer (N1) speed F5-1
- Power Train System 2-132
  - Chip detectors 2-142
  - Lubrication system 2-133
  - Maintenance panel 2-153

Subject — Para., Fig., Table Number

Oil caution lights 2-141
Oil pressure indicator 2-137
Oil pressure selector switch 2-138, F2-25
Oil temperature indicator 2-139
Oil temperature selector switch 2-140, F2-26
Power Turbine Inlet Temperature (Ptit) Indicator 2-66
Power Turbine Overspeed 5-20
Speed Governor 2-48
Preflight Check 8-10
Protective Covers 2-284
Pulleys, Cable 4-43

Q

(Not Applicable)

R

Radar Altimeter 2-248
Radar Signal Detecting Set 4-1
Controls and function control 4-2
Controls and function indicator 4-3, F4-2
Normal operation 4-4
Ramp (See Cargo Loading Ramp)
Ramp Controls 6-54, F6-18
Ramp Operation 6-70
Direction Finder Set (AN/ARN-89) 3-25
Controls and function 3-26
Normal operation 3-27
Receptacles
Cabin utility (AC/DC) 2-170
Cockpit utility 2-169
Strobex/Vibrex blade track 2-172
Rescue Door, Lower 6-35
Resonance, Ground 9-39
Restraint (Cargo) 6-84
Rotor Blades 2-144
Rotor Blade or Drive Shaft Failure 9-37
Rotor Speed Measuring System Failure 9-38
Rotor System 2-143
Blade failure 9-37
Blades 2-144
Hub covers 2-284, F2-54
Limitations 5-28
Starting and shutdown limits 5-9
Tachometers 2-143
Running Landing to Water 8-43

Subject — Para., Fig., Table Number

S

Safety Belts, Troop 6-18
Salt Water Operation 8-92
Hovering 8-94
Power deterioration 8-93
Screens, Engine Inlet 2-42
Searchlight 2-211
Control switches 2-213
Filament switches (pilot and copilot) 2-212
Normal operation 2-215
Position switches 2-214
Sea State Chart T5-2
Sea State Limits 5-36
Seat
Pilot's and copilot's 2-20, F2-5
Troop 6-15
Troop commander's 6-20
Security, Helicopter 2-285, F2-55
Self-Tuning Dynamic Absorbers 2-25
Servicing, Parking, and Mooring 2-263
Auxiliary Power Unit 2-271
Engine oil system 2-270
Fuel system servicing 2-267
Fuel types 2-265
Hydraulic systems 2-273
JP-4 equivalent fuel T2-4
JP-5 equivalent fuel T2-5
Servicing 2-264, T2-3
Single-point pressure refueling 2-268
Tire servicing 2-278
Transmission oil system 2-272
Servicing Diagram F2-48
Sequence Valve, Ramp Control 6-56
Shoring 6-89
Shoulder Harness Inertia Reel 2-24
Shutdown (Engine) 8-45
Single-Engine Service Ceiling 9-5, F9-3
Single-Point Pressure Refueling 2-268
Sliding Windows 2-19
Smoke and Fume Elimination 9-53
Spare Lamps Stowage Box 2-168
Starting Apu 8-22
Starting Engines 8-23
Starting System 2-59
Starter On Caution Lights 2-61
Static Line Retriever 4-49, F4-29
Station Loading 6-87, F6-24
Steady-State Torque Limitations 5-15
Steering and Swivel Lock System 2-5
Control box 2-6, F2-4
Control switch 2-7
Caution light 2-9

Subject — Para., Fig., Table Number

  Isolation switch 2-10
Stowage-Cargo Hook F4-31
Stowage Provisions (Cargo Loading) 6-62
Strength Areas (Cargo Compartment) 6-37
Strobex Blade Track 2-172, F2-28
Structural Anti-Icing 2-147
Surface Wind (Starting and Shutdown) Limitations 5-9
Swivel Lock System 2-5
  Operation 2-7

T

Takeoff 8-30
  Comparison of techniques 8-35
  Climb 8-36
  Crosswind 8-34
  Level acceleration 8-32
  Maximum performance 8-32
  Normal takeoff 8-31
Takeoff Chart 7-26, F7-8
Taxiing Check 8-26
Thrust Control
  Thrust Control Rod Brake Switches 2-98
Thrust Magnetic Brake Failure, Cockpit Control Driver Actuator 9-88
Tiedown Devices 6-92
  Operation F6-25
Tire Pressures 2-278, F2-48
Tiedown Fittings 6-92, F6-29
Torque Malfunctions 9-28
Torquemeter 2-65
Towing helicopter 2-279, F2-52
  Alternate 2-281
  Normal 2-279, F2-52
Transformer-Rectifiers 2-196
Transient Torque Limitations F5-1
Transmissions 2-132
  Chip detector 2-142
  Limitations 5-36
  Lubricating system 2-133
  Maintenance panel 2-153
  Oil pressure indicator and selector switch 2-137, F2-25
  Oil temperature indicator and selector switch 2-139, F2-26
  Oil temperature or pressure light illumination 9-30
Transmission Chip Detector Caution Light Illumination 9-36
Transmission Torque Limitations 5-15
Transponder System 3-59
  Computers 3-62
  Controls and function 3-63
  Receiver-transmitter 3-60
  Transponder control panel 3-61, F3-15
Troop Alarm 2-33
  Switch 2-34, F2-10
Troop Jump Lights 2-33
  Switch 2-35, F2-10
Troop Loading 6-19
Turbulence and Thunderstorm Operation 8-80
  Flight in Thunderstorms 8-84
  Flight in Turbulent Air 8-81
  In turbulent air 8-83
  Prior to entering turbulent air 8-82
Turn and Slip Indicator 2-254
Troop Seats 6-15, F6-7
  Installation 6-16, F6-8
  Stowage 6-17
  Troop commander seat 6-20
Troop Warning Panel F2-10
Turning Radii F2-3
Typical Cockpit and Controls F2-5

U

Uhf Radio Set (AN/ARC-164) 3-10, F3-4
  Controls and function 3-11
  Normal operation 3-12
Universal Heading Reference System (AN/ASN-43) 3-28
  Controls and function 3-29
Uniformly Distributed Loads 6-38
Use of Shall, Should, and May 1-12
Utility Hatch 6-34
Utility Hydraulic System 2-123
  Hand pump 2-128
  Maintenance panel 2-153, F2-27
  Power transfer units 2-124, F2-24
  Pressure caution lights 2-130
  Pressure indicators 2-131
Utility Hydraulic System Failure 9-68
Utility Lights (C-4A) 2-227, F2-39
Utility Receptacles Receptacles
  Cabin, AC 2-170
  Cabin, DC 2-171
  Cockpit 2-169

V

Vertical Velocity Indicator 2-251
Vehicle Tiedown 6-99, F6-28, F6-29
Ventilating System 2-176

Subject — Para, Fig., Table Number

Vhf Navigation Set
  (AN/ARN-123) ... 3-22, F3-9
  Controls and function ... 3-25
  Normal operation ... 3-29
Vhf Radio Set (AN/ARC-186) ... 3-10, F3-5
  Controls and function ... 3-11
  Normal operation ... 3-12
Vibration Absorbers ... 2-25
Vibration Isolators (Floor) ... 6-36
Vibrator Contact Failure ... 2-189
Voice Security System
  (TSEC/KY-58) ... 3-16, F3-7
  Controls and Functions ... 3-17
  Normal operation ... 3-18

W

Warning, Caution and Notes ... 1-2
Warning Signals ... 9-4
Water Operations
  Autorotative landings ... 5-42
  Gross weight ... 5-38
  Landings ... 8-42
  Limitations ... 5-34
  Night operations ... 5-35
  Operation time limit ... 5-37
  Rotor starting and shutdown ... 5-41
  Running landings ... 8-43
  Sea state limits ... 5-36
  Taxiing limitations ... 5-39
  Touchdown speed ... F5-8
Weight, Balance, and Loading
  Cargo loading ... 6-31
  General ... 6-3
  Fuel/oil ... 6-9
  Loading limits ... 6-102
  Mission equipment ... 6-30
  Personnel ... 6-12
Winch ... 4-40, F4-20
  Accessories ... 4-43
  Controls ... 4-41, F4-26
  Operation ... 4-42
Windows, Pilot and Copilot sliding ... 2-19
Windshield Wipers ... 2-164
  Control switch ... 2-165

X

(Not Applicable)

Y

(Not Applicable)

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6	2-1 a			In line 6 of paragraph 2-1a the manual states the engine has 6 cylinders. The engine on my set only has 4 cylinders. Change the manual to show 4 cylinders.
81		4-3		Callout 16 on figure 4-3 is pointing at a bolt. In key to figure 4-3, item 16 is called a shim. Please correct one or the Other.
125	line		20	I ordered a gasket, item 19 on figure B-16 by NSN 2910-00-762-3001. I got a gasket but it doesn't fit. Supply says I got What I ordered, so the NSN is Wrong. Please give me a good NSN

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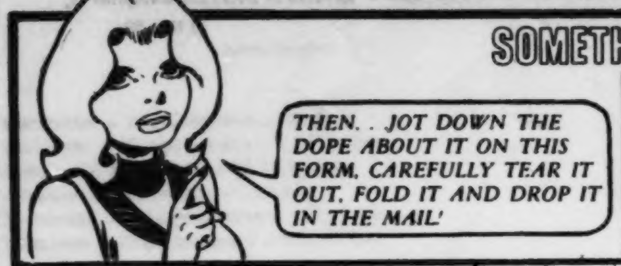
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TEAR ALONG PERFORATED LINE

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

PIN: 051968-000